Wet-Weather Bacterial Loading for Little Harbor TMDL
Quality Assurance Project Plan

Version 2 – Final

April 25, 2003

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A2 – Table of Contents

A2 – Table of Contents 2
List of Tables........ 3
List of Figures 3
A3 – Distribution List 4
A4 – Project/Task Organization 6
A5 – Problem Definition/Background (chg) 8
A6 – Project/Task Description 10
A7 – Quality Objectives and Criteria 12
A8 – Special Training/Certification 16
A9 – Documents and Records 16
B1 – Sampling Process Design 18
B2 – Sampling Methods 23
B3 – Sample Handling and Custody 24
B4–Analytical Methods 24
B5 – Quality Control 24
B6/B7 – Instrument/Equipment Testing, Inspection, Maintenance, Calibration and Frequency 25
B8 – Inspection/Acceptance Requirements for Supplies and Consumables 25
B9 – Non-direct Measurements 26
B10 – Data Management 26
C1 – Assessments and Response Actions 28
C2 – Reports to Management 29
D1 – Data Review, Verification and Validation 30
D2 – Verification and Validation Procedures 30
D3 – Reconciliation with User Requirements 30
References 32

Appendix A: Assessment of the Accuracy of Various Discharge Estimation Methodologies
Appendix B: Standard Operating Procedure for Culvert Flow Measurements
Appendix C: NHDES-NHPHL Shellfish Program, Routine Monitoring QA/Field Data Sheet
Appendix D: NHDES Laboratory Services Login and Custody Sheet
Appendix E: NHDES Stormwater Flux Field Data Sheet
Appendix F: SOP for Sampling Teams
Appendix G: SOP for Data QA/QC

List of Tables

Table 1. QAPP Distribution List 4
Table 2: Municipal contacts for Little Harbor TMDL 5
Table 3: Impaired waters due to bacteria pollution in the Little Harbor/Back Channel area 9
Table 4. Project Schedule Timeline 11
Table 5: Accuracy and Precision Data Quality Objectives 12
Table 6: Special Personnel Training Requirements 16
Table 7: Number of bacteria sources of each type in Little Harbor and Back Channel 18
Table 8: Phase I Field Sampling Summary 19
Table 9: Ambient harbor and tributary stations for Phase II sampling 21
Table 10: Phase II Field Sampling Summary 21
Table 11: Sample Requirements 23
Table 12: Instrument/Equipment Calibration Table 25
Table 13: Project Assessment Table 28
Table 14: Reports to Management 29

List of Figures

Figure 1. Project organizational chart 7
Figure 2: Little Harbor TMDL Study Area 8
Figure 3: Geomean FC concentrations in Little Harbor for different rainfall conditions 9
Figure 4: Quantile Plot of RPD from Duplicate Ambient Samples for FC 13
Figure 5: Ambient harbor stations for Phase II sampling 22

A3 – Distribution List

Table 1 presents a list of people who will receive the approved QAPP, the QAPP revisions, and any amendments.

Table 1. QAPP Distribution List

QAPP Recipient Name	Project Role	Organization	Telephone number and Email address
Phil Trowbridge	Project Manager	DES Watershed Management Bureau	603-271-8872 603-661-7561 (mobile) ptrowbridge@des.state.nh.us
Peg Foss	Project QA Officer	DES Watershed Management Bureau	603-271-5448 mfoss@des.state.nh.us
Gregg Comstock	Program Manager	DES Watershed Management Bureau	603-271-2983 gcomstock@des.state.nh.us
Rachel Rainey	Laboratory QA Officer	DES Laboratory	603-271-2993 rrainey@des.state.nh.us
Mona Freese	Laboratory Officer	DES Laboratory	603-271-2992 mfreese@des.state.nh.us
Andrea Donlon	Program QA Coordinator	DES Watershed Management Bureau	603-271-8862 adonlon@des.state.nh.us
Vincent Perelli	DES Quality Assurance Manager	NH DES Planning Unit	603-271-8989 vperelli@des.state.nh.us
Chris Nash	Field Sampling Coordinator	DES Watershed Management Bureau	603-430-7900 603-781-2393 (mobile) cnash@des.state.nh.us
Ken Edwardson	Field Sampling Team Leader	DES Watershed Management Bureau	603-271-8864 kedwardson@des.state.nh.us
Natalie Landry	Field Sampling Team Leader	DES Watershed Management Bureau	603-433-0877 603-498-9307 (mobile) nlandry@des.state.nh.us
Matthew A. Wood	Field Sampling Team Leader	DES Watershed Management Bureau	603-271-8475 603-785-4266 (mobile) mwood@des.state.nh.us
Rob Livingston	Field Sampling Team Leader	DES Watershed Management Bureau	603-271-3398 603-496-3568 (mobile) rlivingston@des.state.nh.us
Ann Reid	Volunteer Coordinator	Great Bay Coast Watch	603-749-1565 603-749-3880 (home) ann.reid@unh.edu
Jean Brochi	EPA Project Officer (National Estuary Program)	EPA New England	617-918-1536 brochi.jean@epa.gov
Alison Simcox	EPA Project Officer (TMDL Program)	EPA New England	617-918-1684 simcox.alison@epa.gov
Arthur Clark	EPA Quality Assurance Officer	EPA New England	617-918-8374 Clark.Arthur@epamail.epa.gov

Based on EPA-NE Worksheet #3

Table 2 contains other useful contacts for this project.

Table 2: Municipal contacts for Little Harbor TMDL

QAPP Recipient Name	Project Role	Organization	Telephone number and Email address
Duty Officer	N/A	Portsmouth Police Department	603-427-1500
Duty Officer	N/A	New Castle Police Department	603-436-3800
Duty Officer	N/A	Rye Police Department	603-964-7450
Peter Britz	Local government liaison	Portsmouth City Environmental Planner	603-431-2006 ext. 215 plbritz@ch.cityofportsmouth.org
Peter Rice	Local government liaison	City of Portsmouth Dept of Public Works	603-766-1416 phrice@pw.cityofPortsmouth.com
David Allen	Local government liaison	City of Portsmouth Dept of Public Works	603-427-1530 603-766-1421 (mobile) Dsallen@pw.cityofportsmouth.com
Robert Beecher	Local government liaison	Town of New Castle	603-431-6710
Susan Zarlengo	Local government liaison	Town of Rye	603-964-9800 susanw@town.rye.nh.us

A4 – Project/Task Organization

This study will be completed by staff from the NH Department of Environmental Services (DES) Watershed Management Bureau with sampling assistance from Great Bay Coast Watch volunteers and laboratory analysis by the DES Laboratory. The US Environmental Protection Agency (EPA) has provided funding for this project.

DES Watershed Management Bureau

Phil Trowbridge, the N.H. Estuaries Project Coastal Scientist, will be the Project Manager under the supervision of Gregg Comstock, supervisor of DES' Water Quality Planning Section. The Project Manager will be responsible for the overall completion of the project, preparation of the final report, preparation and maintenance of the approved QA Project Plan, and will be the primary contact between DES and EPA.

Peg Foss the TMDL Coordinator for the DES Water Quality Planning Section will act as the Project QA Officer. The Project QA Officer will be responsible for data validation and verification.

Chris Nash, Supervisor of the DES Shellfish Program, will be the Field Sampling Coordinator who is responsible for tracking potential storms. The Field Sampling Coordinator will notify the Project Manager when a favorable storm is predicted. The Project Manager will notify all members of the sampling teams by email to hold the date. As the storm nears, the Field Sampling Coordinator will update the Project Manager regarding the suitability of the storm and the Project Manager will keep the rest of the sampling crews informed. The final decision on whether to mobilize the crews will be made by the Project Manager who will mobilize the crew members through telephone calls.

Natalie Landry, Matthew A. Wood, Rob Livingston, and Ken Edwardson, all of the DES Watershed Management Bureau, will be Field Sampling Team Leaders. During each sampling date, each of the Field Sampling Team Leaders will be paired with other DES staff or volunteers on a field sampling team. The teams will collect environmental samples during storms and deliver the samples to the Project Manager at the end of each day. The field teams will be able to communicate with the Project Manager via cellular phones to resolve any problems.

Great Bay Coast Watch

Ann Reid of Great Bay Coast Watch will organize volunteers to be paired with the Field Team Leaders to assist with the sampling effort.

DES Laboratory

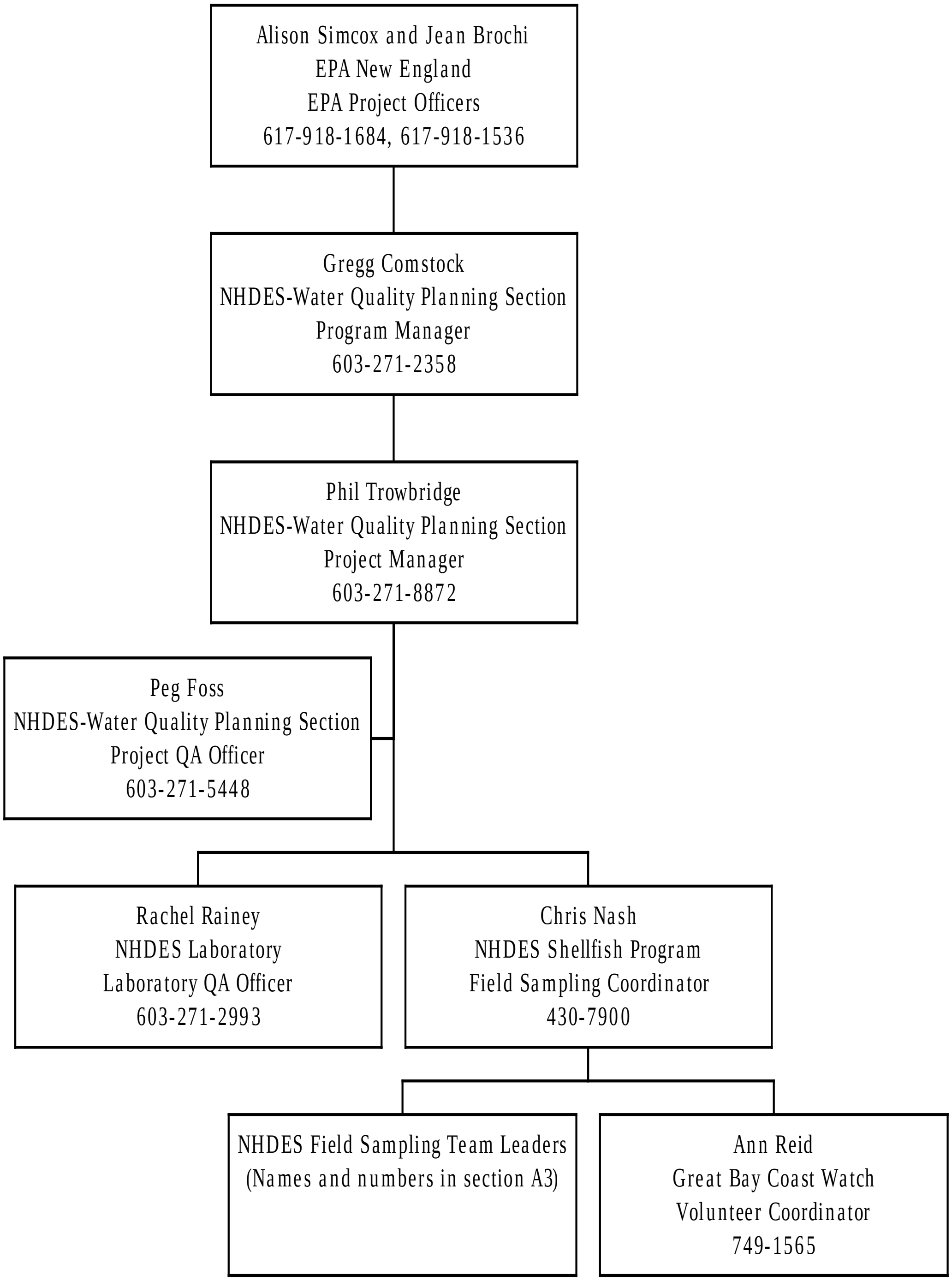
Rachel Rainey is the Project Manager and QA officer for the DES Laboratory Services Unit (LSU). She will be responsible for conducting the analyses and communicating any analytical problems to the Project Manager.

US EPA

Funding for this project is being provided by EPA via the NH Estuaries Project (NHEP) and the TMDL Program. Jean Brochi is the Project Officer for the NHEP and Alison Simcox is the Project Officer for the TMDL Program. Final reports will be submitted to both EPA programs. These reports will be made available to the public upon request.

Figure 1 shows an organizational chart for this project.

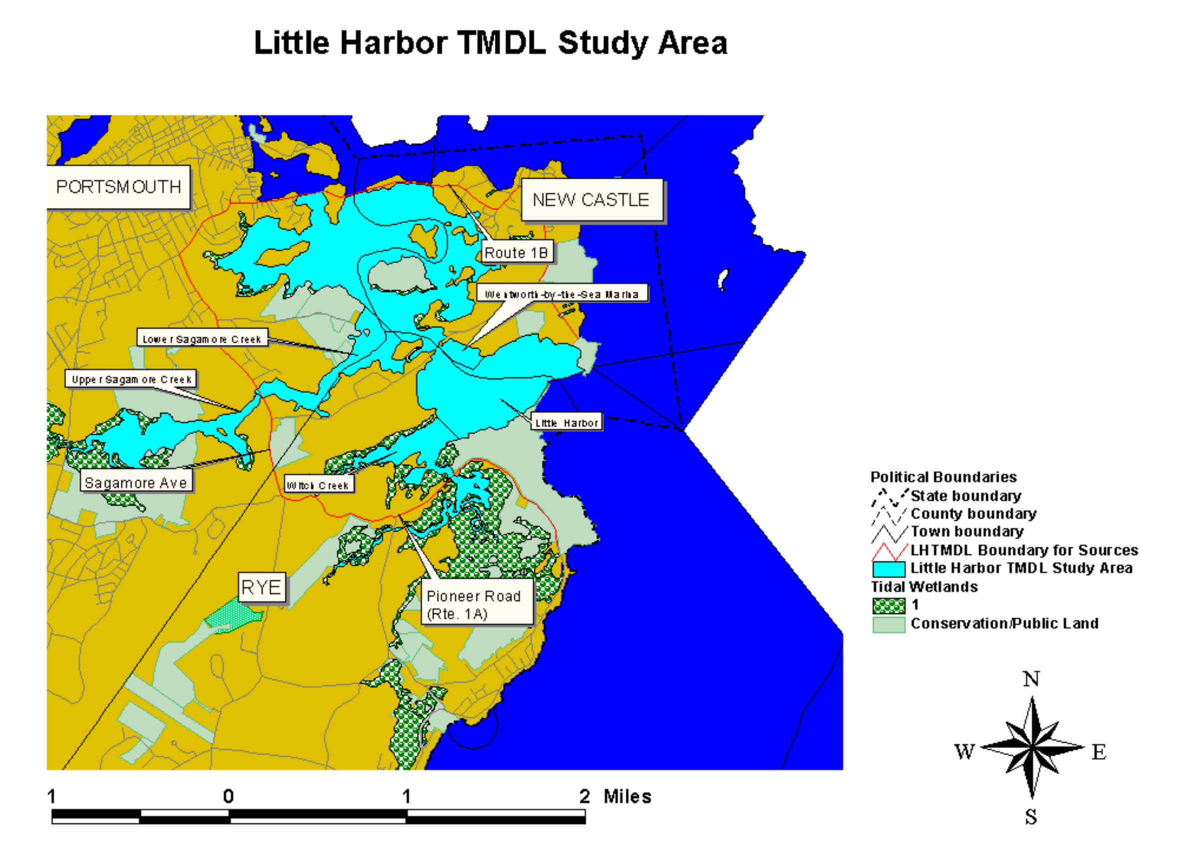
Figure 1. Project organizational chart



A5 – Problem Definition/Background (chg)

The study area for this project is Little Harbor and Back Channel which straddle the towns of Portsmouth, Rye, and New Castle (Figure 2).

Figure 2: Little Harbor TMDL Study Area



Little Harbor and tributaries to Little Harbor (Back Channel, Sagamore Creek, Witch Creek) were included on NH's 2002 list of impaired waters due to bacteria pollution. The bacteria pollution affects the designated uses of shellfishing and primary contact recreation. The specific assessment units in the Little Harbor/Back Channel area on the impaired waters list for bacteria are shown in Table 3.

Table 3: Impaired waters due to bacteria pollution in the Little Harbor/Back Channel area

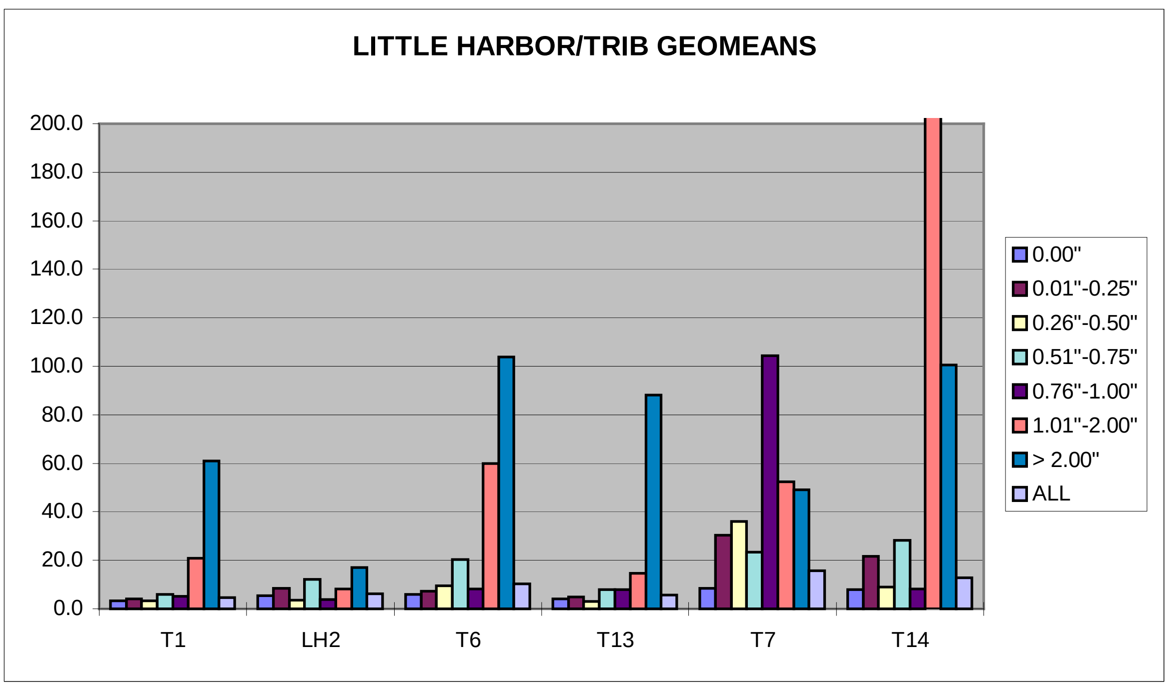
Name	Assessment Unit	Area (acres)	Bacteria Impairment
Little Harbor	NHEST600031002-02	197.98 ac.	Shellfishing
Witch Creek	NHEST600031002-01	93.34 ac.	Shellfishing
Wentworth Marina	NHEST600031001-08	14.73 ac.	Shellfishing**
Back Channel	NHEST600031001-05	421.64 ac.	Shellfishing** Primary Contact Recreation*
Upper Sagamore Creek	NHEST600031001-03	95.86 ac.	Shellfishing
Lower Sagamore Creek	NHEST600031001-04	76.24 ac.	Shellfishing** Primary Contact Recreation*

*Listing for primary contact recreation was due to untreated sewage discharges, not water quality violations.

** Shellfishing prohibited because this area is classified as a safety zone.

The bacteria concentrations in the harbor have been shown to be correlated with rainfall, leading to the conclusion that wet-weather discharges are a major source of bacteria to the harbor (see Figure 3, from DES, 2001).

Figure 3: Geomean FC concentrations in Little Harbor for different rainfall conditions



In order to identify the sources of bacteria to the harbor, the DES Shellfish Program conducted a sanitary survey of Little Harbor and Back Channel in accordance with National Shellfish Sanitation Program (NSSP) guidelines (DES, 2001). Between 1999 and 2001, all of the properties along the shoreline of Little Harbor and Back Channel were surveyed for potential sources of bacteria. One hundred thirty nine potential sources were found. Most of the sources were sampled for bacteria during dry weather conditions. Only a few of the large sources were monitored after rainfall events. Therefore, despite the extensive work completed for the Little Harbor Sanitary Survey, there is still incomplete information on the loading from the pollution sources during wet weather, which is the critical time period for achieving the water quality standards. One of the recommendations from the study was:

> *"Sampling of potential stormwater/wet weather sources of pollution identified in the shoreline survey should be pursued. Estimations of discharge from each source should be made concurrently with the bacterial sampling. Such data will be invaluable to efforts to identify and eliminate the sources of pollution that make the rainfall condition on harvesting necessary."*

The goal of this study is to implement this recommendation.

This study will measure bacteria concentrations and flow from the bacteria sources around the harbor during wet-weather conditions. The details of the work to be performed are provided in Section A6. DES Water Quality Section will use the results of this study (as well as other information) for the "Source Assessment" section of a bacteria Total Maximum Daily Load (TMDL) report for Little Harbor. The results of the study will also be used by the DES Shellfish Program and DES Watershed Assistance Section to determine how best to allocate restoration funds.

A6 – Project/Task Description

Sampling Plan Development Tasks

- Each of the 139 potential bacteria sources in the Little Harbor/Back Channel area from DES (2001) will be GPS'ed, photographed, and evaluated for accessibility and ease of taking flow measurements. No environmental measurements will be taken at the sources during this task so this task will proceed in parallel with the development of this QA Project Plan. After all the sources have been GPS'ed, the pipe and stream sources inside the loop formed by the highlighted (red) roads on Figure 2 will be selected for sampling in the first phase of the study (expected to be approximately 75 sources). The known sources on the outside of these roads are mostly in the upper reaches of Sagamore Creek which is surrounded by conservation land and salt marsh (Figure 2).

Training Tasks

- Field sampling staff will be trained by the Project Manager on the sampling and analysis methods and safety measures that will be used for this program. Records of the field training will be kept by the Project Manager (see section A8).

Sampling Tasks

- The first sampling phase of the project will be to measure fecal coliform (FC) concentrations and flow from each of the 75 selected sources during 2 different wet-weather events. At each source, the flow and FC concentration will be measured just once during each storm. The flow and bacteria measurements will be combined to estimate the instantaneous loading from each source. The 20 sources with the highest instantaneous loads will be chosen to be monitored more intensively during the second phase of the project.
- For the second sampling phase of the project, stormwater FC concentrations and flow will be monitored at 20 sources throughout two or three different storms. For each storm, FC concentrations and flow at each source will monitored approximately hourly in order to characterize changes in bacteria concentrations and flow over the storm hydrograph.

- For the second phase storms, FC concentrations at stations in the harbor will be monitored on the day before and the day after each storm. In addition, FC concentrations in the two main tributaries will be monitored hourly during each storm.

Analysis Tasks

- For the 20 sources monitored for the second phase of the study, measurements of flow will be combined with FC concentrations to estimate the bacteria loads over the duration to the storm. The equations that will be used to calculate loads are shown in Section A7.

Report Preparation

- The sampling results, loading calculations, and a QA self-audit will be summarized in a report to the NH Estuaries Project by 12/31/03.
- The results of the loading analyses will be included in a TMDL report which will be submitted to EPA Region I as a draft by the end of 2003. The public participation component of the TMDL and final revisions will be completed in 2004.

Table 4. Project Schedule Timeline

Activity	Dates (MM/DD/YYYY)		Product	Due Date
	Anticipated Date(s) of Initiation	Anticipated Date(s) of Completion		
QAPP Preparation	03/17/03	04/30/03	QAPP document	04/30/03
Sampling Plan Development Tasks	03/17/03	04/30/03	Database of source locations	04/30/03
Training	05/01/03	05/07/03	Training records	05/07/03
Phase I wet-weather monitoring for 2 storms	05/07/03	05/30/03	Field and lab data packages	05/30/03
Phase II wet-weather monitoring and analysis for 2 to 3 storms	06/01/03	10/31/03	Field and lab data packages	10/31/03
TMDL Preparation	11/01/03	12/31/03	Draft TMDL document	12/31/03
NHEP Report Preparation	11/01/03	12/31/03	Final report to NHEP	12/31/03
Public Participation	01/01/04	04/30/03	Public participation records	04/30/04
Final TMDL Report	05/01/04	06/30/04	Final TMDL document	06/30/04

Based on EPA-NE Worksheet #10.

A7 – Quality Objectives and Criteria

Two environmental measurements will be made for this study: (1) FC concentrations in stormwater and ambient harbor water, and (2) flow of stormwater. The data quality objectives for each of these measurements are described below.

Table 5: Accuracy and Precision Data Quality Objectives

Parameter	Measurement Range	Precision	Accuracy	Maximum Total Error (1)	Reporting Limit
Fecal Coliforms – Overall for stormwater samples (1ml dilution)	100-20,000 (#/100ml)	60% RPD	NA (see "accuracy" text)	±60%	100 (#/100ml)
Fecal Coliforms – Overall for harbor and tributary samples (10ml dilution)	10-2,000 (#/100ml)	40% RPD	NA (see "accuracy" text)	±40%	10 (#/100ml)
Stormwater flux	0-15 (cfs)	20% RPD	±32% (low flow, <0.5 cfs) ±14% (med flow, 0.5-3.0 cfs) ±8% (high flow, >3 cfs)	±38% ±24% ±22%	0.1 (cfs)

Notes:

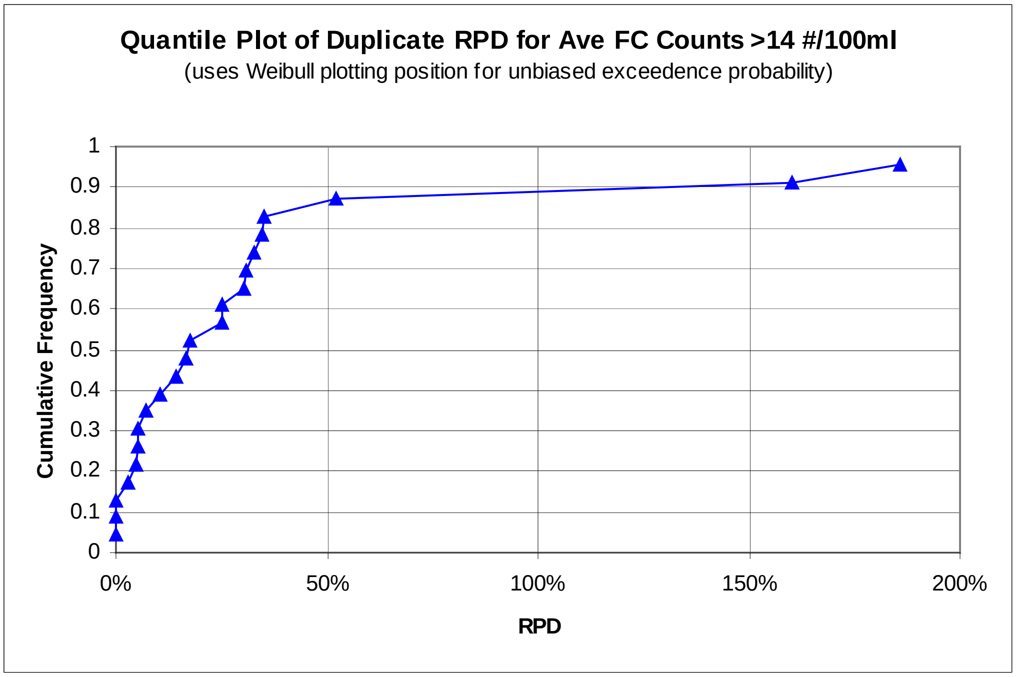
(1) Accuracy error and precision error can be assumed to be independent, random variables. Therefore, the total error in the measurement can be calculated to be root mean square of the two errors:

$$TotalError = \sqrt{AccuracyError^2 + PrecisionError^2}$$

Precision: The concentrations of FC in stormwater are expected to be highly heterogeneous due to fluctuating inputs from rainfall. The 1997 DES Stormwater Characterization Study (DES 1997) found RPDs for *E. coli* duplicate samples between 1.5 and 60% (25% on average) for two storm drains in Concord NH over seven storms. Differences between field duplicate samples collected from storm drains in Little Harbor will mostly represent heterogeneity in the stormwater medium, not lack of uniformity in the field sampling methods. As a result, the precision data quality objective for stormwater FC samples has been set at the highest RPD observed in the 1997 study (60%) to match the natural heterogeneity in stormwater that has already been observed.

For the FC samples from ambient harbor samples, the data quality objective for field duplicates will be 40% RPD. This value was determined after analyzing field duplicates of FC measurements (by plate counts) collected in Hampton Harbor by the DES Shellfish Program during 2000. For this study, FC concentrations in ambient samples are expected to be >14 #/100ml. Consequently, only the RPDs for samples with average FC concentrations > 14 #/100ml were used (n=21). A quantile plot of these data (Figure 4) show that greater than 80 percent of the samples were clustered together with RPDs less than 40% (see Figure 3). The few samples with RPDs greater than 40% plotted far away from the rest of the samples and appeared anomalous. Based on these data, an RPD of 40% appears to separate duplicate samples reflective of natural variability in the medium and duplicate samples reflective of potential sampling error. Therefore, 40% was adopted for the data quality objective for ambient harbor samples in this study.

Figure 4: Quantile Plot of RPD from Duplicate Ambient Samples for FC



The field duplicates of stormwater and ambient harbor samples will capture error from all stages of the data collection and analysis. Therefore, RPDs between field duplicates will be considered representative of the total error in the FC measurements.

Duplicate measurements of flow will be conducted to characterize heterogeneity in flow or field methods. The data quality objective for the field duplicates will be 20% RPD.

Accuracy: No accuracy objectives have been set for the FC analyses because there is no practical way to perform spiked samples or analyze standard reference materials for coliforms.

For flow measurements, the accuracy of the methods that will be used have been assessed by the DES Shellfish Program in Appendix A. The methods involve calculating the stormwater flux by measuring the velocity and cross sectional area of the flow. Flux estimates from these methods were checked against accurate measurements of flow (collecting the stormwater in container of known volume and recording the time). During the Little Harbor field work, it will not be possible to confirm the accuracy of this method because the bottom of the outfall pipes are set flush with the ground, and, therefore, cannot be evaluated using volumetric measurements. However, if the SOPs for flow measurements are followed (Appendix B and F), the resulting flow estimates should be accurate to within the limits established in Appendix A. These limits have also been adopted as the data quality objectives for stormwater flux.

Representativeness: The objective of this study is to make measurements that will be representative of the loading of bacteria from wet-weather sources around Little Harbor. To that end:

- For the first phase of the project, all the bacteria sources identified as being pipes or streams close to the growing area (e.g., inside the highlighted roads on Figure 2) will be monitored. The sources with the highest individual loadings in the first phase of sampling will be chosen for more intensive loading measurements in the second phase of the project. As a result, the sources that will be monitored for bacteria loadings are expected to be representative of the major stormwater sources of bacteria to the harbor.

- To be representative of the stormwater loading, this study needs to capture the pre-storm condition, elevated FC concentrations during the "first flush", and the decline of the high first flush concentrations as the storm progresses. Teams will collect pre-storm samples and a round of "first flush" samples during the first hour of the storm. Subsequent measurements of bacteria and flow from the storm drains will be taken as frequently as possible, at approximately 30-60 minute intervals. Therefore, the proposed sampling design will capture in both the elevated FC concentrations of the first flush and the changing concentrations during the storm, so that the resulting loading estimate is representative of the overall loading from these pipes.
- The stations that will be sampled in the harbor are used by the DES Shellfish Program to assess growing areas and, therefore, are considered representative of the harbor. They are the stations that will be used to make future decisions about shellfish growing areas, which makes them uniquely representative of harbor conditions.

Comparability: The field and laboratory methods for this study are identical to those used by the DES Shellfish Program for shoreline surveys and other wet-weather monitoring projects. Therefore, the results will be comparable to other similar studies. The laboratory analyses by the Membrane Filtration Method are based on procedures from Standard Methods for the Examination of Water and Wastewater (18^{th} edition, 9222D).

Sensitivity. Previous studies of wet weather loadings to Hampton Harbor showed that the proposed laboratory methods are adequate (expected FC concentrations of >100 for stormwater and >10 for harbor and tributary samples) (DES, 2003). The quantification limit for stormwater flux in the table in Section A7 is based on the specifications of the instrument (+/-0.1 cfs). However, field studies reported in Appendix A demonstrated that the method to be used for this study produced accurate measurements of flow down to 0.02 cfs at the Hubbard Road culvert on 4/1/02.

Completeness: This study proposes to monitor a total of three storms between June and October for the second phase of the project. However, the study will be sufficiently complete if two storms are monitored. Therefore, a data completeness percentage of 67% is needed.

Total Error For Project: The objective of this sampling program is to monitor loads of bacteria from individual storm drains over the course of three storms. The instantaneous loading from a storm drain at time i (L_i) (in billion bacteria/day) will be calculated by:

$$L_i = CF \cdot F_i \cdot C_i$$

Where F_i is the stormwater flux from an individual drain at time i (in cfs) and C_i is the concentration of bacteria in the stormwater sample (in counts per 100ml) collected at the same time as the flux measurement. CF is a conversion factor of 16,992 (1000 ml/l*28.32 l/ft^3*60s/minute). The error associated with each instantaneous loading calculation will be the combination of the error in the measurements of F and C. The following equation defines the variance in L_i (Var(L)) given known variance in Fi and Ci (Var(F) and Var(C), respectively) (Kline, 1985):

$$Var(L) = \left(\frac{\partial L}{\partial F}\right)^2 \cdot Var(F) + \left(\frac{\partial L}{\partial C}\right)^2 \cdot Var(C)$$

Assuming that the variance is approximately equal to the square of the absolute error (δL), the equation reduces to:

$$\frac{\delta L}{L} = \sqrt{\left(\frac{\delta F}{F}\right)^2 + \left(\frac{\delta C}{C}\right)^2}$$

Where

100% • δL/L = the total percent error in instantaneous loading estimate;

100% • δF/F = the total percent error in the stormwater flux estimate;

100% • δC/C = the total percent error in the FC concentration.

Applying the maximum total error associated with the data quality objectives for FC in stormwater samples (60%) and stormwater flux measurements (22-38%) from Table 3, the maximum total error in each instantaneous loading estimate will be ±64-71%.

The cumulative loading of bacteria from each outfall over the course of the storm (for n stormwater samples) will be calculated by:

$$Ltot = \int_{t=0}^{t=t} L(t)dt \approx \sum_{i=1}^{i=n-1} \frac{(L_i + L_{i+1})}{2} \cdot (t_{i+1} - t_i) = \sum_{i=1}^{i=n-1} Lave_i \cdot \Delta t_i$$

Where Ltot has units of bacteria loaded over the course of the storm. The relative error for each $(L_i + L_{i+1})/2$ term ("Lave") in the summation will be approximately (δL/L)•√2. There will not be any significant error in the $(t_{i+1} - t_i)$ term ("Δt") because this is simply the time between the collection of $sample_i$ and $sample_{i+1}$ (in minutes). Therefore, the total error for each product of $Lave_i$ and Δt_i will be (δL/L)•√2. Assuming that each $Lave_i \bullet \Delta t_i$ term in the summation is approximately equal to their average values (Lave and Δt, respectively), Ltot for n stormwater samples can be approximated by:

$$Ltot = \sum_{i=1}^{i=n-1} Lave_i \cdot \Delta t_i \approx (n-1) \cdot Lave \cdot \Delta t$$

and the cumulative error for Ltot can be expressed as:

$$Var(Ltot) \approx (n-1)^2 \cdot Var(Lave \cdot \Delta t)$$

Assuming that the variance of Ltot is approximately equal to the square of the absolute error, δLtot, this expression can be rewritten as:

$$\frac{\delta Ltot}{Ltot} = \frac{\delta(Lave \cdot \Delta t)}{Ltot} \cdot (n-1)$$

Substituting (n-1) • Lave•Δt for Ltot on the right hand side and then (δL/L)•√2 for δ(Lave•Δt)/Lave•Δt shows that the relative error in the cumulative loading estimate will be equal to the average relative error in the individual loading estimates:

$$\frac{\delta Ltot}{Ltot} = \frac{\delta(Lave \cdot \Delta t)}{Lave \cdot \Delta t} = \left(\frac{\delta L}{L}\right) \cdot \sqrt{2}$$

Therefore, for the data quality objectives listed in Table 5, the maximum error in the cumulative loading estimate will be ±64-71%. The majority of this error is associated with the high data quality objective for precision for FC in stormwater samples (60% RPD). This high precision value is due to real heterogeneity in FC concentrations in the stormwater samples, and therefore cannot be eliminated.

A8 – Special Training/Certification

Prior to the first storm sampling event, all the Field Sampling Team Leaders for this project will be trained in the methods for collecting stormwater samples, measuring flows, and data recording procedures. The Field Sampling Team Leaders will be taken to the field sampling locations to orient them to the area. The Project Manager will brief the Team Leaders on logistics for each sampling effort including: where/when samples should be delivered, emergency communication networks, personal protective equipment, and field sampling methods. Attendance will be mandatory for all Field Sampling Team Leaders. Attendance sheets will be kept on file in the DES Water Quality Planning Section office.

Table 6: Special Personnel Training Requirements

Project function	Description of Training	Training Provided by	Training Provided to	Location of Training Records
Wet-weather monitoring	Field methods for collecting FC samples and measuring flows and field sampling logistics. This training will be conducted once at the beginning of the field season.	Phil Trowbridge (Project Manager)	All Field Sampling Team Leaders	DES Water Quality Planning Section TMDL records

Based on EPA-NE Worksheet #7.

A9 – Documents and Records

QA Project Plan: The Project Manager will be responsible for maintaining the approved QA Project Plan and for distributing the latest version of the plan to all parties on the distribution list in section A3. A copy of the approved plan will be on file at the DES Water Quality Planning Section offices in Concord.

Field Data Reports: The field data sheets will be used for this project. The Project Manager will collect all field data sheets by the end of each sampling day. All the field data sheets will be photocopied and then distributed in the following manner:

- DES Shellfish Program Routine Monitoring QA/Field Data Sheet (Appendix C): Field observations for ambient harbor samples will be recorded on this sheet during the ambient harbor runs. Pertinent information will be transferred to the DES Laboratory's Login and Custody Sheet (see below). The original field data sheets for the ambient sites will be given to the DES Shellfish Program for data entry. The photocopies will remain with the Project Manager.
- DES Laboratory's Login and Custody Sheets (Appendix D): Field data on sample collection at pipes and tributaries will be recorded directly on this form. Field data for the ambient harbor samples will be transferred to this form from the DES Shellfish form after each round of interval sampling. The original login and custody sheet will be delivered to the DES Laboratory along with the samples. The photocopies will remain with the Project Manager.
- DES Stormwater Flux Field Data Sheet (Appendix E): Field data on measured stormwater fluxes will be recorded in the field on the standardized form. The Project Manager will retain the original field data sheets for stormwater fluxes and will give the copies to the DES Shellfish Program for redundancy.

Laboratory Data Reports: Data packages from the laboratory will be hardcopy laboratory data sheets containing the FC concentration for each sample.

Final Report to EPA: Field and laboratory data will be reported to EPA Region I in a TMDL report for Little Harbor and a final report to the NHEP. The Project Manager will prepare the reports. Drafts of these reports are expected to be complete by 12/31/03 (depending on the number of suitable storms that occur in 2002).

Archiving: The original field and laboratory data sheets, QA Project Plan, and the final report to EPA will be kept on file by the DES Water Quality Planning Section for a minimum of 10 years after the publication date of the final report.

B1 – Sampling Process Design

There will be two distinct sampling efforts for this study. Therefore, this Section B1 has been divided into two subsections corresponding to the first and second phase sampling efforts.

Phase I Sampling Effort

The objective of this sampling effort is to monitor FC and flow at approximately 75 sources around the harbor during two storms. Each source will be monitored once per storm.

Phase I Sampling Locations

Approximately 139 stormwater sources have been identified around the harbor. The following table summarizes the number of sources of each type and the average FC concentration from mostly dry-weather samples.

Table 7: Number of bacteria sources of each type in Little Harbor and Back Channel

Potential Pollution Source Category	Direct*		Indirect*		Grand Total
	# sources	Ave FC**	# sources	Ave FC**	
Groundwater Seep	28	760	7	11	35
Intermittent Stream	1	27			1
Marina	3	NA			3
Mooring Field	1	NA			1
Other	2	510			2
Perennial Stream	4	250	7	2,800	11
Pipe	46	52,000	17	280	63
Road Swale	1	2			1
Tidal Creek	5	200	17	460	22
Grand Total	91		48		139

* Note: "Direct" indicates that the source discharges directly to the shellfish growing area. "Indirect" sources discharge to a stream or creek that eventually discharges to the growing area.

**FC concentrations in counts/100ml. The number of sources does not necessarily equal the number of samples taken from the category.

For the first phase of the study, a set of 75 sources will be monitored. Sources listed as "groundwater seeps", "marinas", "mooring fields", and "other" are not expected to be wet-weather sources, so these 41 sources will be excluded. Also, three sources listed in the DES database as "Investigated/Clean" will be eliminated because DES staff have already gathered sufficient water quality data on these sources to verify that they are not significant. Therefore, out of the full list of 139 sources, 95 sources in the categories of "pipe", "perennial stream", "intermittent stream", and "tidal creek" will be considered for the study. This list of 95 will be reduced to approximately 70-75 sources by selecting only those sources that fall inside the highlighted road boundary in Figure 2.

The final list of sites cannot be generated at this time because the sources must be GPS'ed and plotted using ArcView software. However, DES will prepare an addendum to this QA Project Plan with the full list of sites for the Phase I sampling with their locations shown on a map before the Phase I sampling begins.

Phase I Storm Selection

Sampling will be initiated for storms that are predicted to have total rainfall >0.25 inches per 24 hours. The Phase I sampling effort will occur in May 2003. Two storms will be monitored. Storms that begin a few hours prior to the time of low tide will be preferred because many of the storm drains are submerged at high tide. Storms will also have to occur during daylight hours, and the normal workweek (excluding Fridays). Short-term storms, such as thunderstorms, will not be targeted because it would be difficult to mobilize field teams on such short notice. The Project Manager will be responsible for selecting the storms and mobilizing the field crews following the procedure described in Section A4.

Phase I Sampling Schedule

When an appropriate storm is predicted, up to six sampling teams will be dispatched to Little Harbor. The Project Manager will assign each team a list of 12-15 sources to monitor during the storm. The teams will collect stormwater samples and measure flow at their sites during the first 3 hours of the storm (4 sites/hour). Sample collection will not begin until stormwater flows have begun (to be determined by the Project Manager). Each team will consist of at least 2 people and will be lead by a Field Team Leader who has been trained according to Section A8.

Phase I Sampling Summary

Table 8: Phase I Field Sampling Summary

Parameter	No. of sampling locations	Samples per event per site	Number of sampling events	Number of field duplicates	Number of bottle blanks	Total number to lab
To be analyzed at the DES lab						
Fecal coliforms	75	1	2 rain events	5% (4/rain event)	0	158 (79/storm)
Measured in the field						
Flow	75	1	2 rain events	10% (8/rain event)	Not applicable	measured *in situ*

Based on EPA-NE Worksheet #9c.

Phase II Sampling Effort

The objective of this sampling effort is to monitoring FC and flow at approximately 20 sources around the harbor during two or three storms. Each source will be monitored hourly throughout the storm.

Sampling Locations for the Second Phase

The list of sites for the Phase II sampling will be chosen based on the results of the Phase I sampling. Out of the 75 sources monitored in the Phase I sampling effort, the 20 sources with the highest individual loadings will be chosen for the Phase II sampling effort. Therefore, a final list of Phase II sites cannot be generated at this time. However, DES will prepare an addendum to this QA Project Plan with the full list of sites for the Phase II sampling with their locations shown on a map before the Phase II sampling begins.

Phase II Storm Selection

Sampling will be initiated for storms that are predicted to have total rainfall >0.25 inches per 24 hours. The Phase I sampling effort will begin in June 2003 and will conclude by November 2003. Up to 3 storms will be monitored. Storms that begin a few hours prior to the time of low tide will be preferred because many of the storm drains are submerged at high tide. Storms will also have to occur during daylight hours, and the normal workweek (excluding Fridays). Short-term storms, such as thunderstorms, will not be targeted because it would be difficult to mobilize field teams on such short notice. The Project Manager will be responsible for selecting the storms and mobilizing the field crews following the procedure described in Section A4.

If no suitable storms have occurred by September 1, 2002, it may be necessary to target smaller storms. The decision to target smaller storms will be made by the Project Manager after consulting with the rest of the project team and the EPA Project Officers.

Phase II Sampling Schedule

When an appropriate storm is predicted, up to five land sampling teams will be dispatched to Little Harbor. The Project Manager will assign each team a list of 4-7 sources to monitor during the storm. The teams will collect “pre-storm” samples, “first flush” samples, and then samples at 30-60 minute intervals for the duration of the storm at all of their sources. Each team will consist of at least 2 people and will be lead by a Field Team Leader who has been trained according to Section A8.

Pre-Storm Samples: Each team will collect “pre-storm” water samples at all their sites before precipitation begins. The teams will also measure “pre-storm” flows if possible.

First Flush Samples: The pipe teams will return to their first sampling site and wait until they notice a significant increase in stormwater flow from the source at which point they will collect a round “first flush” samples and flow measurements at all of their sites over the next hour.

Interval Samples: After collecting the first flush samples, the pipe teams will continue to rotate through all of their sites every 30 to 60 minutes for the duration of the storm, collecting stormwater samples and flow measurements at each source. The field teams will continue to monitor the sources until either (1) the Project Manager terminates the effort; or (2) the stormwater outfalls assigned to the team are inundated by the rising tide.

Harbor and Tributary Water Quality Sampling for the Second Phase

Before and after each storm, the 9 ambient stations in Little Harbor and Back Channel will be sampled for FC (Table 9). These stations cover the full extent of the harbor and its major tributaries and are considered representative of the major shellfish growing areas in Little Harbor (Figure 5).

“Pre-storm” samples will be collected from all the ambient stations immediately before the storm. “Post-storm” samples will be collected after the rainfall has ceased and within 24 hours of the pre-storm samples. Data from the ambient harbor stations before and after the storm will be used to evaluate the effects of stormwater bacteria loads on ambient water quality in the growing areas. Stations T6 and LHB6 are very near to each other, as are stations T13 and LHB13. The purpose for including both the “T” sites and the “LHB” sites in these locations is to evaluate whether FC concentrations in the near shore environment (at the “T” sites) are higher than at the “LHB” sites farther offshore.

In addition, FC concentrations at the tributary stations in Sagamore Creek (LHB8) and Berry’s Brook (T14) will be monitored hourly throughout the storm on the same frequency as the pipe and stream sources. Flow at these tributary locations will not be measured during the storm.

Table 9: Ambient harbor and tributary stations for Phase II sampling

Field Team	Station No.	Latitude	Longitude	Comments
Boat Team	LHB1	43.0558	-70.7169	Off frost point jetty at green can at mouth of Little Harbor
Boat Team	LHB2	43.0572	-70.7211	Along New Castle shoreline
Boat Team	LHB5	43.0706	-70.7381	Between Shapleigh and Goat islands, north edge of Back Channel
Boat Team	LHB6	43.0533	-70.7283	boat site for shore site T6, in channel
Boat Team	T6	43.0526	-70.7298	Witch Creek at Sheafe's Point
Boat Team	LHB9	43.0708	-70.7428	Between Shapleigh Island and mainland, north edge of Back Channel
Boat Team	LHB13	43.0583	-70.7289	boat site for shore site T13, in channel under Rt1B bridge near Wentworth marina
Boat Team	T13	43.0580	-70.7300	bridge between New Castle and Portsmouth (mainland) at Wentworth Marina
Boat Team	LHB16	43.0622	-70.7367	Middle of Back Channel
Land Team	LHB8	43.0542	-70.7436	Sagamore Creek tributary station. To be monitored hourly.
Land Team	T14	43.0478	-70.7282	Berry's Brook tributary station. To be monitored hourly.

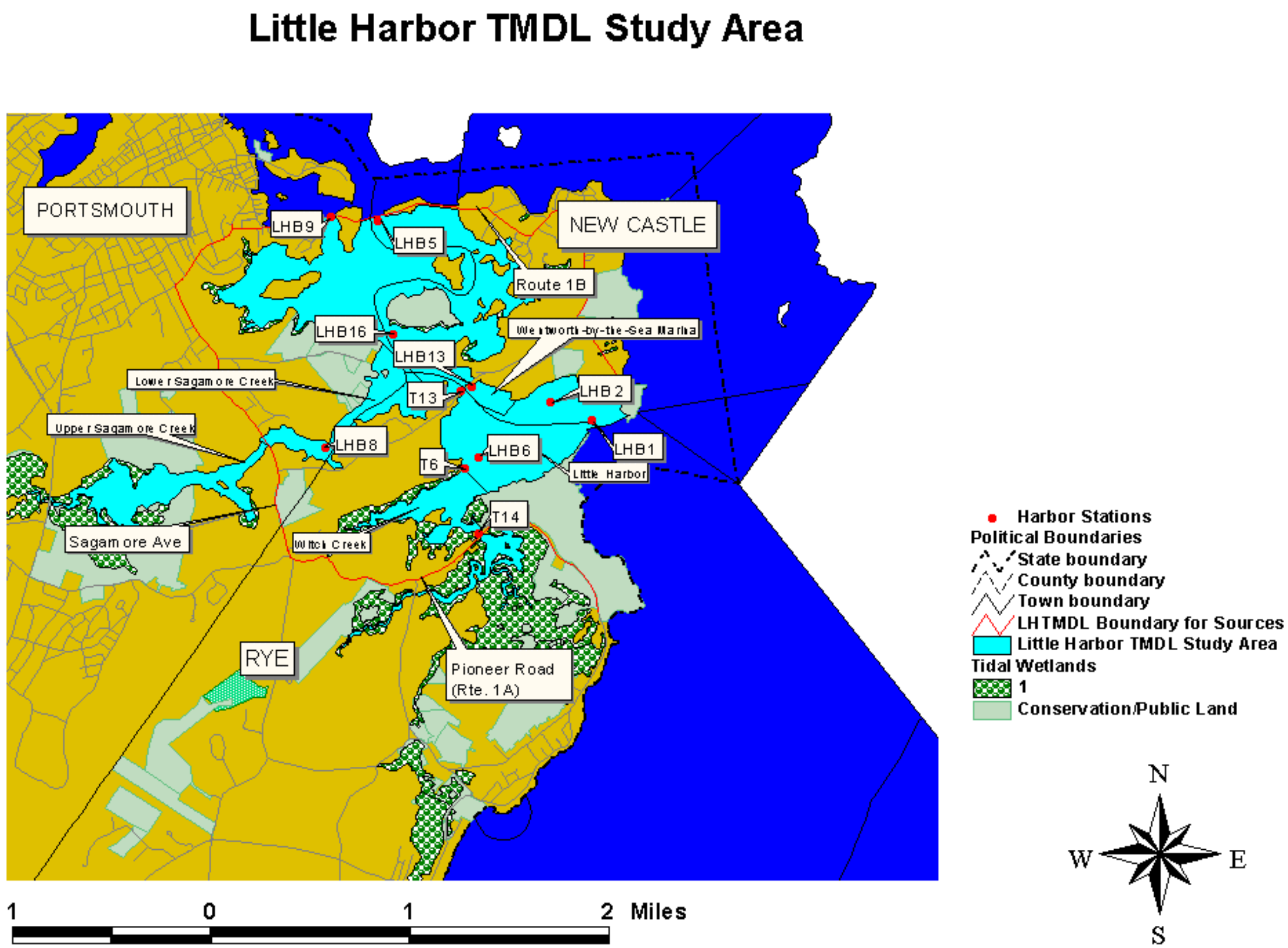
Phase II Sampling Summary

Table 10: Phase II Field Sampling Summary

Parameter	No. of sampling locations	Samples per event per site	Number of sampling events	Number of field duplicates	Number of bottle blanks	Total number to lab
To be analyzed at the DES lab						
Fecal coliforms in stormwater	20	5 (assuming a 5 hr storm)	2 or 3 rain events	5% (5/rain event)	0	210 to 315 (105/storm)
Fecal coliforms at harbor sites (day of storm)	11	1	2 or 3 rain events	5% (1/rain event)	0	24 to 36 (12/storm)
Fecal coliforms at harbor sites (day after)	11	1	2 or 3 rain events	5% (1/rain event)	0	24 to 36 (12/storm)
Fecal coliforms at tributary sites	2	5 (assuming a 5 hr storm)	2 or 3 rain events	5% (1/rain event)	0	22 to 33 (11/storm)
Measured in the field						
Flow	20	5 (assuming a 5 hr storm)	2 or 3 rain events	10% (10/rain event)	Not applicable	measured *in situ*

Based on EPA-NE Worksheet #9c.

Figure 5: Ambient harbor stations for Phase II sampling



B2 – Sampling Methods

Fecal Coliforms

Samples are collected in 250 mL-clear, polyethylene, pre-sterilized Nalgene bottles, supplied by the DES laboratories. On sample bottle labels, the sample date, sample time, and sample site identification code will be recorded using water proof/ indelible ink.

The bacterial sample will be collected by positioning the mouth of the bottle opposite the direction of flow. If the water is deep enough, the sample should be collected using a sampling pole by thrusting the bottle 8-12 inches under the surface of the water using a continuous "U" shaped motion until almost full, leaving a one-inch air space. Samples are collected with the container completely submerged, so as to minimize the collection of water on the immediate surface. The bottle may need to be shaken to remove water, allowing for a one-inch air space. Samples are collected without disturbing the substrate. If the substrate is disturbed while collecting a sample, the sampler will discard the sample and bottle and will collect another sample away from the disturbed area to minimize contamination possibilities.

Samples will be immediately stored on ice or ice pack in a light-tight cooler until delivery to the laboratory.

The temperature of all samples are measured using an infrared sensor and recorded when they are delivered to the laboratory to confirm that the proper temperature was maintained, preferably between 0-10°C, during sample collection and transport.

Stormwater Flux

Stormwater flux will be measured at each stormwater pipe by measuring the cross sectional area of flow in the pipe and its average velocity. For flows greater than 2 inches in depth and greater than 0.1 ft/s (the detection limit of the meter), current meters from Global Water will be used to measure the velocity. For shallower flows or flows less than 0.1 ft/s, the velocity will be inferred from the time required for a miniature float to move a known distance. The SOPs for making the flow measurements are attached in Appendix B.

A one page SOP for field teams is attached as Appendix F.

Table 11: Sample Requirements

Analytical parameter	Collection method	Sampling SOP	Sample volume	Container size and type	Preservation requirements	Max. holding time (preparation and analysis)
Fecal coliforms	Grab	See text and Appendix F	150 mL	250 mL sterile clear polyethylene	Chilled to ≤ 10ºC	8 hours (except under extenuating circumstances - see B3)
Stormwater flux	measured in-situ	See text and Appendix B, F	NA	NA	NA	NA

Based on EPA-NE Worksheet #12b.

Field Corrective Measures

The Project Manager will be responsible for making decisions in the field to correct for any field sampling problems. All of the Field Sampling Team Leaders and the Project Manager will have mobile phones for communication in the field. If a Field Sampling Team Leader is not able to follow the SOPs for sampling listed in the QA Project Plan, they will call the Project Manager and explain the problem. The Project Manager will decide on the course of action and will relay consistent information to all the other Field Sampling Team Leaders.

B3 – Sample Handling and Custody

Water samples for bacteria analysis will be stored and transported on ice in coolers. The water temperature of the samples is measured by DES Laboratory staff using an infrared sensor and is recorded on the data sheet at the time of sample delivery. The samples will be delivered to and analyzed by the laboratory within 8 hours of collection. Although DES will make every effort to meet the 8 hour holding time requirement, if the stormwater sampling must occur after 5 pm due to timing of the storm and low tide, the samples will not be analyzed until the following morning. The samples would be stored on ice in the secure DES Laboratory cold room overnight and would be analyzed no later than 30 hours after collection. While this duration exceeds the holding time for the Membrane Filtration Method (SOP 10.34a), 30 hours is considered an acceptable holding time by APHA (1970). If samples are stored in the laboratory cold room, they will be signed in and signed out of storage on the laboratory login and custody sheet with the date, time, and staff noted.

Each sampling team will be responsible for delivering their samples and field data sheets to the Project Manager by the end of the sampling event. Depending on the timing of the study, the Project Manager may also arrange for one-half of the samples to be delivered to the laboratory in the middle of the sampling event in order to meet holding times and not overwhelm the laboratory staff.

B4–Analytical Methods

Fecal coliforms in stormwater and ambient samples will be analyzed by the DES Laboratory using the Membrane Filtration Method (SOP 10.43a on file with EPA). This will be conducted by the DES Laboratory. Samples of stormwater will be analyzed at the 1 ml dilution. Pre-storm samples and samples from the ambient harbor sites will be analyzed at the 10 ml dilution.

The Laboratory QA Officer will be responsible to resolving any problems with the laboratory method and informing the Project Manager of the quality of the data.

B5 – Quality Control

Precision Calculations

Precision of FC and flow measurements will be assessed from field and laboratory duplicates using relative percent difference (RPD):

$$RPD = \frac{|x_1 - x_2|}{\frac{x_1 + x_2}{2}} \times 100\%$$

where x_1 is the original sample concentration (or flow)
x_2 is the duplicate sample concentration (or flow)

Fecal Coliforms

Overall Precision: Each team will collect a field duplicate for every 20th fecal coliform sample. The RPD between the duplicate pair will be calculated using the formula at the beginning of section B5. If one of the two samples is qualified as "less than" or "greater than" a value, the reported value will be used in the RPD calculation. The RPD will be compared to the data quality objective in Table 5. If the RPD is less than or equal to the data quality objective, the duplicate samples will be considered "in control". If the RPD is greater than the data quality objective, the two duplicate samples will be flagged for investigation by the Project QA Officer.

Stormwater Flux

Each team will repeat every 10th field measurement of stormwater flux. The RPD between the duplicate pair will be calculated using the formula at the beginning of section B5. If the RPD is less than or equal to the data quality objective in Table 5, the duplicate samples will be considered "in control". If the RPD is greater than the data quality objectives, the two duplicate samples will be flagged for investigation by the Project QA Officer.

Project QA Officer Investigations

For any measurement flagged for investigation, the Project QA Officer will review the field and laboratory data sheets and talk with the field sampling team that collected the sample to determine if the large variation can be explained by deviation from field sampling SOPs. If all SOPs were appropriately followed, the difference between the duplicate samples will be considered representative of natural heterogeneity in the sampled medium. The conclusions of the Project QA officer will be documented in a report to the Project Manager.

B6/B7 – Instrument/Equipment Testing, Inspection, Maintenance, Calibration and Frequency

Field instruments used during water sample collection include a Global Water "Global Flow Probe" flow meter.

Global water flow meters are calibrated at least annually when their batteries are changed. See Appendix B for calibration procedures.

Laboratory instruments and equipment are inspected, maintained and calibrated by the laboratory. Refer to the DES Standard Operating Procedures for the Fecal Coliform Test by Membrane Filtration (SOP 10.43a on file with EPA) and the Quality Systems Manual: State of New Hampshire Department of Environmental Services Laboratory Services Unit.

Table 12: Instrument/Equipment Calibration Table

Equipment name	Procedure	Frequency of calibration	Acceptance criteria	Corrective action	Person responsible
Global Water "Global Flow Probe"	Appendix B	Annually	Code = 33.31	Reset code to 33.31	Field operator

Based on EPA-NE Worksheet #14.

B8 – Inspection/Acceptance Requirements for Supplies and Consumables

Field Inspection: Sample bottles will be inspected by field personnel before sample collection. Bottles that may have been contaminated will be returned to the laboratory for sterilization.

Laboratory Inspection: The procedures used by the DES Laboratory to inspect supplies and consumables are described in SOP 10.43a (on file with EPA).

B9 – Non-direct Measurements

Tidal data are used in making decisions on when to sample. Samples are collected during tidal conditions suitable for sample collection. Data on time of low tide are acquired from National Oceanic and Atmospheric Administration tide charts, using times for the Portland, ME base station (available at http://www.co-ops.nos.noaa.gov/cgi-bin/predictions.cgi?stn=8418150+Portland+,+ME). Using this information and the tidal lag for each sampling site, the appropriate tidal conditions for sampling can be determined.

Rainfall data are used to measure the amount of liquid precipitation from each storm. The weather stations from which data will be acquired are Portsmouth, NH and Seabrook Station.

Predictions of weather from internet sources and the National Weather Service will be used to identify potential storms meeting the criteria for this study. Some specific sources include: www.accuweather.com and the National Weather Service office in Grey ME (207-688-3216 or 800-482-0913 after 5 pm).

B10 – Data Management

Data Recording Procedures: Field data will be recorded on standardized field data sheets (Appendices C, D, and E). When completing these forms, the field staff will follow the procedures from the DES *Quality Management Plan (QMP)* (June 2001) sections 6.3 and 8.7, especially the sections excerpted below:

- 6.3.a. The records shall clearly indicate the date of the field observation, sample collection, sample preparation, equipment calibration or testing, and other related activities.
- 6.3.b. The records shall include the identity of personnel involved in making observations, collecting field data, sampling, preparation, calibration, or testing.
- 6.3.c. The record-keeping system shall facilitate the retrieval of all working files and archived records for inspection and verification purposes.
- 6.3.d. All documentation entries shall be signed or initialed by responsible staff. The reason for the signature or initials shall be clearly indicated in the records such as "sampled by", "prepared by", or "reviewed by".
- 6.3.e. All generated data except those that are generated by automated data collection systems, shall be recorded directly, promptly, and legibly in permanent ink.
- 6.3.f. Entries in records shall not be obliterated by methods such as erasure, overwritten files, or markings. All corrections to record-keeping errors shall be made by one line marked through the error and initialed. These criteria also shall apply to electronically maintained records, where applicable.

For the purposes of this study, the identities of all field staff should be recorded as their first initial and full last name. Also, because the sampling will occur during rainstorms, waterproof paper and pencils will be used to record the field data.

Manipulations of Raw Data: There will be no manipulations of raw data prior to data entry.

Data Entry Procedures: In accordance with DES Watershed Management Bureau's QA-QC SOP for data entry, stormwater data from field and laboratory data sheets will be entered into a database by one DES staff person and then checked by another. The specific procedures will follow the SOP which is provided as Appendix G.

Ambient harbor data will be entered following the protocols of the DES Shellfish Program. Chris Nash is responsible for data entry. All ambient data are managed in Microsoft Access databases. As data are entered, the appropriate section of the QA/Field Data Sheet is initialed and dated. Chris Nash is assisted in data entry verification by Matt Wood or a program volunteer. As data entry is verified, the entry in the database field entitled "ENTRYQA" is changed from a "No" (the default value) to a "Yes," and the appropriate section of the QA/Field Data Sheet is initialed and dated.

Data Management: Electronic data from the stormwater samples will be maintained in an Excel spreadsheet by the DES Water Quality Planning Section. Data from this spreadsheet will ultimately be imported into the DES Shellfish Program Shoreline database. Electronic data from the ambient stations will reside in the DES Shellfish Program Water Quality database. Management of hardcopy data and documents is described in Section A9.

Data Security: All databases will be maintain on password protected computers. Hardcopy files will be stored in a secured office with a key-card system (6 Hazen Drive, Concord NH) to which only DES employees have access.

Data Analysis: The procedures for data analysis were described in Section A7.

C1 – Assessments and Response Actions

In order to determine that field sampling, field analysis and laboratory activities are occurring as planned, field staff and laboratory personnel shall meet, after the first sampling event, to discuss the methods being employed and to review the quality assurance samples. At this time all concerns regarding the sampling protocols and analysis techniques shall be addressed and any changes deemed necessary shall be made to ensure consistency and quality of subsequent sampling. Assessment frequencies and responsible personnel are shown in the following table.

Table 13: Project Assessment Table

Assessment Type	Frequency	Person responsible for performing assessment	Person responsible for responding to assessment findings	Person responsible for monitoring effectiveness of corrective actions
Field sampling audit	Once after first sampling day	Phil Trowbridge Project Manager DES	Phil Trowbridge Project Manager DES	Phil Trowbridge Project Manager DES
Field analytical audit	Once after first sampling day	Phil Trowbridge Project Manager DES	Phil Trowbridge Project Manager DES	Phil Trowbridge Project Manager DES
DES Laboratory Services Fixed Lab	Weekly	Rachel Rainey Lab QA/QC Officer DES	Rachel Rainey Lab QA/QC Officer DES	Rachel Rainey Lab QA/QC Officer DES

Based on EPA-NE Worksheet #27b.

Field Sampling Audit: QAPP deviations and project deficiencies determined during the field sampling assessment will be evaluated for source of deviation and corrected with verbal communications in the field and documented in field log books. Any necessary written/structural changes will be made through a revision of the SOP for that activity (and this QAPP). Field sampling activities will be monitored to determine compliance.

Field Analytical Audit: QAPP deviations and project deficiencies determined during the field analytical assessment will be evaluated for source of deviation and corrected with verbal communications in the field and documented in field log books. Any necessary written/structural changes will be made through a revision of the SOP for that activity (and this QAPP). Field analytical activities will be monitored to determine compliance.

DES Laboratory Services Fixed Laboratory Audit: QAPP deviations and project deficiencies determined during the DES Laboratory Services fixed laboratory assessments will be addressed immediately. Replicates and critical range tables will be checked with data to determine if sources of error exist. Any deviations in results will be addressed in both written and verbal formats, and future sampling will be monitored to verify that compliance is reached.

C2 – Reports to Management

The reports to management are summarized in the following table.

Table 14: Reports to Management

Report	Frequency	Author	Recipient	Action expected of recipient
Quarterly reports to the NH Estuaries Project	Quarterly from 6/30/03 until 12/31/03	Phil Trowbridge	Jennifer Hunter, Director, NHEP	Review work completed compared to expected schedule in contract.
DRAFT TMDL Report for Little Harbor	One DRAFT report, expected by 12/31/03	Phil Trowbridge	Alison Simcox, TMDL Coordinator, EPA Reg I	Review and comment on TMDL study and implementation plan
Final TMDL Report	One report, expected by 6/30/04	Phil Trowbridge	Alison Simcox, TMDL Coordinator, EPA Reg I	Approve TMDL study and implementation plan

D1 – Data Review, Verification and Validation

The Project QA Officer will be responsible for conducting a review of the project file to verify that all the procedures of the QA Project Plan were in fact followed. The QA Project Officer will prepare a memorandum to the Project Manager documenting the completion of the review and any inconsistencies between the actual methods and the QA Project Plan that were identified.

D2 – Verification and Validation Procedures

The Project QA Officer will be responsible for reviewing each section of the QA Project Plan and verifying with the Project Manager and the Field Team Leaders than the procedures in the plan were in fact followed.

The Project QA Officer will also be responsible for evaluating results from QC samples and determining whether data quality objectives have been met. Specifically, the Project QA Officer will

- Calculate the RPD between duplicate samples to determine if the data quality objectives for precision were met (for more details see Section A7 and B5).
- Review the sign-off blocks on the field data sheets to determine whether the data entry procedures from Section B10 were followed.
- Calculate the data completeness for the project and compare it to the data quality objective of 67%.
- Verify that each field team contained at least one member who had been trained by the Project Manager based on training records.
- Verify that any changes to SOPs and procedures based on field and laboratory audits listed in Section C1 were documented, communicated to all participants, and successfully implemented.

The Project QA Officer will prepare a memorandum for the Project Manager with findings detailing any non-conformities with QA Project Plan procedures, any exceedences of the data quality objectives in QC samples, and any data from the project that should be qualified.

D3 – Reconciliation with User Requirements

The Project Manager will be responsible for reconciling the results from this study with the requirements of the TMDL (the ultimate use of the data). Results that are qualified by the Project QA Officer may still be used in the TMDL report if the uncertainty in the results is clearly reported to decision-makers. Because the stormwater samples will be collected synoptically during specific storms, it will not be possible to collect additional samples to confirm any questionable results. To that end, the Project Manager will:

1. Review data with respect to sampling design.

2. Review the Data Verification and Validation reports from the Project QA Officer.

3. If any of the results have been qualified by the Project QA Officer, calculate the cumulative error in the loading estimates to determine whether data can be used to for the TMDL report.

4. Draw conclusions from the data.

In summary, if the quality objectives and criteria in section A7 have been met, and a final TMDL report has been submitted to EPA, then the project goals have been met. If the quality objectives are not met, or the final TMDL report is not submitted to EPA, then further work will be performed as an addendum to this QAPP or under a new QAPP.

References

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Appendix A

Assessment of the Accuracy of Various Discharge Estimation Methodologies

Prepared by Chris Nash, DES Shellfish Program Manager (April 2002)

INTRODUCTION

The NHDES Shellfish program routinely performs shoreline surveys for pollution sources in shellfish growing waters. These surveys require an assessment of bacterial loading from potential pollution sources. Loading assessments typically involve not only collection of water samples for bacterial analyses, but also estimation of discharge.

Estimates of discharge from potential pollution sources, many of which are stormwater pipes, can be made using a variety of methodologies. Perhaps the most simple, direct, and accurate is the volumetric method, in which the time required to fill a container of known volume is measured. Unfortunately, this method is often impractical, as most stormwater pipes lack the clearance under the pipe required to capture the flow. Therefore, other means of estimating discharge must be employed.

The purpose of this study is to assess the relative accuracy of a variety of discharge estimation techniques that could be used in NHDES Shellfish Program shoreline surveys. The results of the study will enable NHDES to select discharge estimation methodologies appropriate to the intended use of the data, and to report on the quality of the discharge estimates generated to potential data users.

Study Design and Methods

The NHDES Shellfish Program initiated a comparative study of discharge estimation methodologies in the spring of 2002. A group of circular pipes of varying diameter, on which a number of discharge measurements would be made under a variety of flow conditions, were identified by program staff (Appendix 1). In order to allow for volumetric measurements of discharge, only pipes with more than six inches of underneath clearance were selected for the study.

On a number of days during both dry and wet weather, discharge estimates were made using some/all of the following methodologies:

Volumetric: The time required to fill the container of known volume (2, 5, and 22 gallon containers are used, as appropriate) is measured three times with a stopwatch that reads to the nearest 0.01 second. The average of the three observed times is used to calculate discharge.

Depth/Diameter/Velocity (with current meter): discharge calculated by the following equation:

$$Q = A*V$$

Where Q = discharge in ft^3/sec
A= cross sectional area of the filled portion of a circular pipe, ft^2
V= velocity of flow, ft/sec

Cross sectional area of the filled portion of the circular pipe is derived from the following equation (CRC, 1974):

$$A = R^2 \cdot \cos^{-1}\left(\frac{R-h}{R}\right) - (R-h)\sqrt{\left(2Rh - h^2\right)}$$

Where A= cross sectional area of the filled portion of the pipe, ft^2
R= radius of pipe, ft
h = depth of water in pipe, ft

In this method, velocity is derived using a flow meter per the manufacturer instructions. The DES Shellfish Program utilizes a "Global Flow Probe" from Global Water, Inc., which is accurate to 0.1 ft/sec. Three velocity measurements are made, and the average is used for the discharge calculation. Depth is measured with a wooden ruler or with a wire affixed to a combination square, to the nearest 1/8 inch.

Depth/Diameter/Velocity (with miniature float): when conditions preclude the use of a velocity meter (e.g., insufficient water depth), velocity must be estimated by using miniature floats. In this method, velocity is derived inserting miniature floats a known distance into the pipe, and observing the time required for the current to carry the float out of the pipe. Depending on the velocity, either a 4-ft or 8-ft rod is used to insert the float into the pipe. When the float is released into the flow, the time required for it to exit the pipe is measured. Three time measurements are made with a stopwatch that reads to nearest 0.01 second, and the average time is used to calculate velocity. Depth is measured with a wooden ruler or with a wire affixed to a combination square, to the nearest 1/8 inch. The same equations presented above are then used to estimate discharge.

For the field study, volumetric measurements were assumed to represent the true value of discharge at each site. The other methods were employed as site conditions allowed. For velocity measurements made with miniature floats, time required to travel over short (4-ft) and long (8-ft) distances were made to determine the most appropriate method.

Error Estimations

To examine how errors in water depth and velocity measurements might affect discharge estimations, sensitivity analyses were performed. Errors in water depth measurements were modeled for three hypothetical flow conditions:

- low flow (1 inch of water in the pipe, velocity of 2 ft/sec)
- moderate flow (3 inches of water in the pipe, velocity of 4 ft/sec)
- high flow (4 inches of water in the pipe, velocity of 7 ft/sec)

For each flow condition, discharge was calculated for 1, 2, 3, and 4-foot pipes the given depth and velocity. Errors in water depth measurement were simulated at 1/8" intervals, up to 0.50 inches. The resulting deviations from the true discharge value, expressed as a percentage of the true discharge value, are presented in Table 1.

Table 1: Percent Deviation from True Discharge due to Errors in Water Depth Measurement

Flow Condition	**Pipe Diam (in)**	**Depth 1/8" off (%diff)**	**Depth ¼" off (%diff)**	**Depth 3/8" off (%diff)**	**Depth 1/2" off (%diff)**
low flow water depth 1in, velocity 2fps	12	20.4	39.2	56.4	71.6
	24	20.5	39.4	56.6	71.8
	36	20.6	39.5	56.7	71.8
	48	20.6	39.5	56.7	71.9
moderate flow water depth 3in, velocity 4fps	12	6.1	12.1	18.0	23.8
	24	6.3	12.5	18.5	24.4
	36	6.3	12.6	18.6	24.6
	48	6.4	12.7	18.8	24.7
high flow water depth 4in, velocity 7fps	12	4.4	8.8	13.1	17.4
	24	4.6	9.2	13.7	18.1
	36	4.7	9.3	13.9	18.4
	48	4.7	9.4	13.9	18.4

Errors in velocity measurements were also modeled for the same three hypothetical flow conditions (low, moderate, and high flow). For each flow condition, discharge was calculated for 1, 2, 3, and 4-foot pipes at the given depth and velocity. Errors in velocity measurements were simulated at 0.1 ft/sec intervals up to 0.5 ft/sec (assuming use of an 8ft rod for the miniature float method, these deviations would result from errors in time measurement of 0.19-0.80 seconds under low flow, 0.05-0.22 seconds under moderate flow, and 0.01-0.07 seconds under high flow). The resulting deviations from the true discharge value, expressed as a percentage of the true discharge value, are presented in Table 2.

Table 2: Percent Deviation from True Discharge due to Errors in Velocity Measurement

Flow Condition	Pipe Diam (in)	V off by 0.1 fps (%diff)	V off by 0.2 fps (%diff)	V off by 0.3 fps (%diff)	V off by 0.4 fps (%diff)	V off by 0.5 fps (%diff)
low flow	12-48	5.0	10.0	15.0	20.0	25.0
moderate flow	12-48	2.5	5.0	7.5	10.0	12.5
high flow	12-48	1.4	2.9	4.3	5.7	7.1

These calculations show that the greatest error can be expected under low flow conditions. Somewhat less error can be expected for high flow conditions.

Field Measurement Results

A summary of actual discharge estimations on the sites depicted in Appendix 1 is presented in Table 3. All depth measurements in Table 3 were made with a wooden ruler. Differences in discharge measurements, expressed as a percentage of the volumetric measurement, are presented in Table 4.

Table 3: Discharge Measurements

DATE	SITE	PIPE DIA. (in)	WATER DEPTH (in)	VOLUMETRIC			DEPTH/DIAM./VELOCITY METHOD		
				2GAL (GPM)	5 GAL (GPM)	22 GAL (GPM)	6-8ft ROD (GPM)	4ft ROD (GPM)	METER (GPM)
3/15/02	Blackwater	48	3			~1320		1113.93	
3/19/02	Hubbard Rd	24	0.5	7.20				7.24	
3/19/02	Hubbard Rd	18	0.375	2.06				5.03	
3/19/02	Upp. Spur Rd	18	0.75	24.00				28.27	
3/19/02	Low. Spur Rd	30	0.75	18.00				48.86	
3/25/02	Upp. Spur Rd	18	1	65.34	62.46			99.09	
3/25/02	Low. Spur Rd	30	0.75	25.46				62.80	
3/25/02	Sawyer Mills	12	0.75		23.23			51.64	
3/26/02	Hubbard Rd	24	1.75		108.30		145.12	164.47	161.24
3/26/02	Hubbard Rd	18	0.875	26.07			41.52	46.35	
3/26/02	Upp. Spur Rd	18	3.25			519.69	715.71	660.13	743.98
3/26/02	Low. Spur Rd	30	1	113.92		113.05	95.76	95.08	111.08
3/26/02	Sawyer Mills	12	1		43.44		84.17	75.48	64.11
4/1/02	Hubbard Rd	24	1.25		61.64		86.57	82.09	
4/1/02	Hubbard Rd	18	0.5	9.31			14.28	14.65	
4/1/02	Upp. Spur Rd	18	2.875			393.05	450.99	482.86	541.68
4/1/02	Low. Spur Rd	30	0.875			74.49	67.03	80.33	
4/1/02	Sawyer Mills	12	0.75		23.57			47.97	

Table 4: Percent Differences Between Volumetric and Depth/Diameter/Velocity Discharge Measurements

DATE	SITE	FLOW COND.	PIPE DIA. (in)	WATER DEPTH (in)	VOLUM. METH. (GPM)	DEPTH/DIAM./VELOCITY METHOD		
						6-8ft ROD (%diff)	4ft ROD (%diff)	METER (%diff)
3/15/02	Blackwater	Mod	48	3	~1320		~21	
3/19/02	Hubbard Rd	Low	24	0.5	7.20		8	
3/19/02	Hubbard Rd	Low	18	0.375	2.06		-126	
3/19/02	Upp. Spur Rd	Low	18	0.75	24.00		-10	
3/19/02	Low. Spur Rd	Low	30	0.75	18.00		-92	
3/25/02	Upp. Spur Rd	Low	18	1	65.34		-70	
3/25/02	Low. Spur Rd	Low	30	0.75	25.46		-74	
3/25/02	Sawyer Mills	Low	12	0.75	23.23		-109	
3/26/02	Hubbard Rd	Mod	24	1.75	108.3	-26	-43	-40
3/26/02	Hubbard Rd	Mod	18	0.875	26.07	-66	-86	
3/26/02	Upp. Spur Rd	Mod	18	3.25	519.69	-37	-26	-43
3/26/02	Low. Spur Rd	Mod	30	1	113.05	27	28	16
3/26/02	Sawyer Mills	Mod	12	1	43.44	-82	-64	-39
4/1/02	Hubbard Rd	Mod	24	1.25	61.64	-40	-33	
4/1/02	Hubbard Rd	Mod	18	0.5	9.31	-53	-57	
4/1/02	Upp. Spur Rd	Mod	18	2.875	393.05	-15	-23	-38
4/1/02	Low. Spur Rd	Mod	30	0.875	74.49	10	-8	
4/1/02	Sawyer Mills	Mod	12	0.75	23.57		-104	

Discussion

Low flow conditions were encountered on 3/15, 3/19, and 3/25. Some rather large differences in discharge estimates were observed, and these are likely due to difficulties with getting an accurate velocity measurement. On these low flow days, water depths are too low for use of a current meter, and a miniature float method of determining velocity must be used. The velocity measured by the miniature float only represents velocity in the top center of the flow. It does not accurately represent flows on the bottom and sides of the pipe, which are likely slower due to friction and probably represent a significant amount of the flow under shallow depth conditions. The float method likely overestimates velocity, which would explain why discharge estimates from depth/diameter/velocity method are higher than the volumetric measurements.

Higher flows were encountered on 3/26, following a one-inch rainstorm. Observed differences on this day were generally greater in the smaller pipes. Most of the differences observed were likely due to difficulties in accurately measuring water depth.

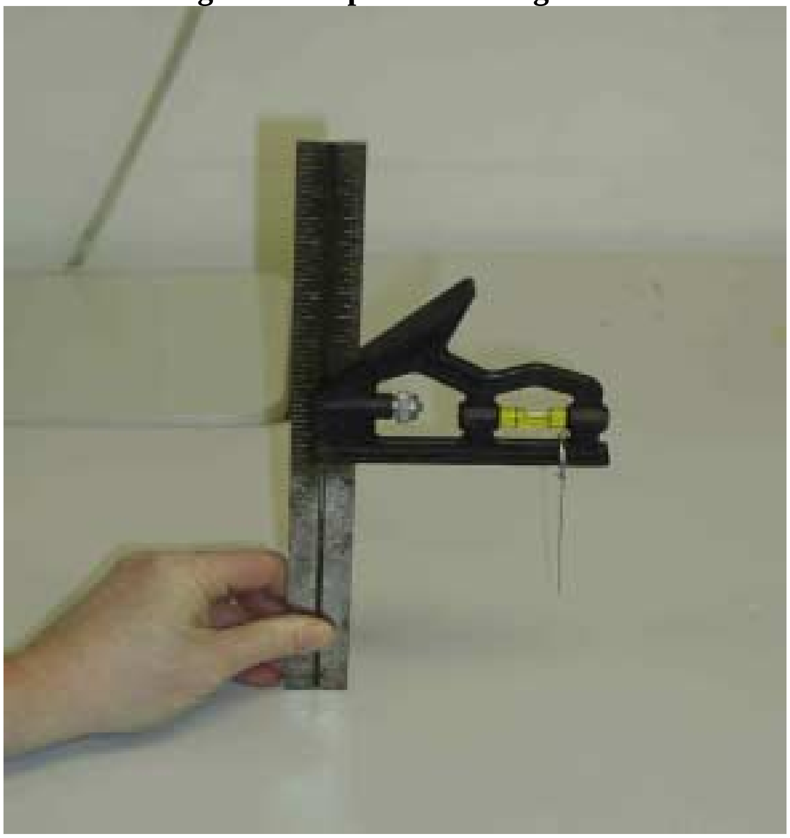
For all measurements except 4/1 (moderate flow following a 0.75-inch storm), water depths were measured using a wooden ruler. At high velocities, errors in estimating water depth may be introduced as the flow "runs up" the ruler, making an accurate measurement difficult. In light of this, and in light of the error estimations presented in Table 1, an alternative tool for reducing error in water depth measurement was developed. By securing a 3-inch long piece of relatively stiff (19 gauge or thicker) galvanized wire to a combination square (Figure 1), much of the error can be eliminated. With the bottom of the combination square set in the deepest section of pipe, the wire can be situated on the upstream side of the flow and lowered to the water surface – this eliminates "run-up" and keeps the sampler's hands out of the water. Furthermore, the ruler on the combination square provides a convenient way to measure depth, and the bubble level helps ensure an accurate measurement.

For the 4/1 measurements, both depth measurement methodologies were employed. The results (Table 5) suggest that the combination square method generally provides for better discharge estimates, in some cases dramatically so. For some of the pipes, the estimate of depth varied by as much as 3/8 of an inch (which can result in errors of 13% to 57%, based on the figures in Table 1).

Table 5: Percent Differences Between Volumetric and Depth/Diameter/Velocity Discharge Measurements Utilizing Two Different Depth Measurement Methods

			DEPTH WITH RULER METHOD				DEPTH WITH COMB.SQUARE METHOD			
				DEPTH/DIAM./VELOCITY METHOD				DEPTH/DIAM./VELOCITY METHOD		
SITE	PIPE DIA. (in)	VOLUM. METH. (GPM)	WATER DEPTH (in)	6-8ft STICK (%diff)	4ft STICK (%diff)	METER (%diff)	WATER DEPTH (in)	6-8ft STICK (%diff)	4ft STICK (%diff)	METER (%diff)
Hubbard Rd	18	9.31	0.5	-53	-57		0.375	2	-3	
Upp. Spur Rd	18	393.1	2.875	-15	-23	-38	2.500	6	-3	-12
Low. Spur Rd	30	74.49	0.875	10	-8		0.750	28	14	
Sawyer Mills	12	23.57	0.75		-104		0.625		-55	

Figure 1: Depth Measuring Tool



Conclusions

Volumetric measurements are always preferable, but rarely feasible in the field setting typically encountered by NHDES Shellfish Program staff.

At low flows and shallow depths, errors in the cross sectional area method can be very large, and are most likely due to erroneous velocity measurements (due to variation in velocity due to friction with the pipe). Improving the accuracy of velocity measurements under such conditions is very difficult. Errors can exceed 75% of the true value.

At higher flows and deeper depths, errors in the cross sectional area method are more likely due to erroneous depth measurements, which can be very difficult to accurately obtain under high velocity conditions. Variation in velocity at different parts of the pipe may also account for some of the error. Errors at moderate/high flows can be 25% or less; however, careful depth measurements can dramatically improve results, perhaps reducing error to 15% or less.

When using a miniature float to determine velocity, better results are generally produced by using a longer rod (8 ft versus 4 ft); however, differences in error between the two methods were not dramatic, and some site conditions require the use of a shorter rod.

The current meter did not produce consistently better results than the miniature float method; however, relatively few comparisons between these methods were made because shallow water depths precluded the use of the current meter. One can expect that as velocities increase with high flow conditions, the chances of significant error using the float method are likely to increase. Furthermore, high flow conditions may make using the float method difficult, perhaps even dangerous. Thus, it may be best to use a current meter under high flow conditions.

Depth measurements should be made using the combination square/wire tool, rather than regular wooden rulers. This tool seems to give better depth measurements, and much better discharge estimates.

Based on the hypothetical error calculations in Tables 1 and 2, as well as the field results, the following errors in discharge measurements, expressed as a percentage of the true value, can be expected (assume 24" diameter pipe):

	Low Flow	Moderate Flow	High Flow
Error due to Depth (w/ comb. Square, 1/8")	20.5	6.3	4.6
Error due to Velocity (w/ meter, 0.1 f/sec)	5	2.5	1.4
Total Error	21	7	5

Note: Total error calculated using standard error propagation methods for independent, random errors in a simple product without coefficients:

$$E_{flow} = [E_a^2 + E_v^2]^{1/2}$$

where
E_{flow} is the total percent error in the flow estimate;
E_a is the percent error in the flow estimate due to uncertainty in the depth measurement;
E_v is the percent error in the flow estimate due to uncertainty in the velocity measurement.

If water depths are too shallow and a float must be used, the velocity measurements are likely to be more in error. Assuming a "high-end" error of 0.5 ft/sec, the following errors in discharge measurements, expressed as a percentage of the true value, can be expected:

	Low Flow	Moderate Flow	High Flow
Error due to Depth (w/comb. Square, 1/8")	20.5	6.3	4.6
Error due to Velocity (w/ float, 0.5 f/sec)	25	12.5	7.1
Total Error	32	14	8

Attachment A

Study Sites

Blackwater Brook Culvert: this 48 inch concrete culvert is located off Blackwater Road in Dover, NH. Elevated flows due to beaver activity upstream make volumetric flow measurements at this site impractical, as flows of 25 gallons per second and higher are commonly observed. Access is not restricted by tides.

Hubbard Road: these 18 inch and 24 inch concrete stormwater pipes drain to a stormwater pond in a Hubbard Road subdivision in Dover, NH. Access is not restricted by tides. Volumetric measurements can be made with 2, 5, and 22 gallon containers on the 24 inch pipe, and with a 2 gallon container on the 18 inch pipe.

Lower Spur Road Culvert: this 30-inch concrete culvert runs underneath the lower section of Spur Road in Dover, NH, and drains stormwater to the tidal portion of the Bellamy River. Access is not restricted by tides. Volumetric measurements are possible with 2 and 22 gallon containers.

Upper Spur Road Culvert: this 18-inch corrugated black plastic culvert runs underneath the upper section of Spur Road in Dover, NH, and drains stormwater to the tidal portion of the Bellamy River. Access at high tide is limited. Low tide volumetric measurements are possible with 2, 5, and 22 gallon containers.

Sawyer Mills: this 12 inch stormwater pipe discharges directly to the Bellamy River adjacent to the Sawyer Mills apartment building in Dover, NH. Access is not restricted by tides. Volumetric measurements are possible with 2, 5, and 22 gallon containers.

APPENDIX B

Standard Operating Procedure for Culvert Flow Measurements

A. Equipment

Global Water FP101-FP201 Global Flow Probe

Specifications:

Velocity Measurement: Propeller
Accuracy: ±0.1 ft/s

Calibration:

This unit only needs to be calibrated if the batteries have been changed. If you did not change the batteries, skip to Section B on the next page.

The computer's set-up sequence is entered automatically when the batteries are changed. You can also enter the set-up sequence at any time by holding both buttons simultaneously for 8 seconds.

- During the set-up sequence, all of the display segments are displayed first, and then "mi" appears for English units (ft/s) and "km " appears for metric units. The left button toggles between English and Metric units.
- Push the right button to enter "CAL "mode. This is your Flow Probe calibration function. Set the calibration at 33.31. **When you change your batteries, you must reset this number**. Pushing the left button increases the number when the arrow points up and decreases the number when the arrow points down.
- To continue the set-up sequence after you have set your English or Metric calibration:
    - Push the Right button-be sure "CAD "is not displayed.
    - Push the Right button-SLEEP will appear. If you are not using your Flow Probe for 1-2 months, leave it in this SLEEP mode, to reduce battery drain.
    - Push the Right button-push the Left button to toggle between 24 hr and 12 hr clock.
    - Push the Right button-push the Left button to set HOUR (time of day).
    - Push the Right button-push Left to set the MINUTE (time of day).
    - Push the Right button-you are now out of Set Up and back in Velocity ("V"). Push the left button to toggle the bottom number between maximum ("mx") and average ("av") velocities. **Set the probe to record the average velocity.**

B. Measuring Flow from a Culvert:

1. Find downstream end of culvert. Record the culvert number (PS#) and the time (in military units) on the field data sheet.

2. Observe whether there is any flow in the culvert (based on eye observations only). **If there is no flow, record "no flow" in the comments section of the field data sheet, and skip to Step 6.** If the pipe is flowing, go to Step 3.

3. Observe whether the culvert is round or a box culvert (rectangular).

   a.) If the culvert is round, measure the diameter of the culvert to the nearest ½ inch and record this value on the field data sheet.
   b.) If the culvert is better approximated by a box culvert (e.g., the bottom of the pipe is full of sediment, or the pipe is deformed or not circular), measure the width of the culvert at the water height to the nearest ½ inch. Record in the "Comments" section of the field data sheet, that the culvert is a "box culvert with width XXX inches".

4. Measure the water depth in the center of the culvert.

   a) If the water depth is less than 8 inches, use the depth measuring tool made out of a combination square (see Appendix A for a description of this tool).
      i. Place the "ruler" end of the combination square down to the bottom of the pipe in the middle of the pipe with the arm of the tool facing upstream.
      ii. Slide the arm down the ruler until the metal wire on the end of the arm is just touching the surface of the water. Be sure to level the device using the bubble level.
      iii. Lock the arm in place by twisting the clamp and then remove the tool from the flow.
      iv. Read the value on the ruler at the bottom of the arm to the nearest 1/8th of an inch and **then subtract 3 inches (to account for the length of the wire).**
      v. Record this depth on the field data sheet to the closest 1/8 inch.

   b) If the water depth in the pipe is more than 8 inches deep, use a collapsible yardstick
      i. Measure the total height of the entire culvert to the closest ¼ inch.
      ii. Measure the distance between the water level and the top of the pipe to the closest ¼ inch.
      iii. Subtract the second measurement from the first measurement. This is the water depth.
      iv. Record this value on the field data sheet to the closest ¼ inch.

5. Measure the average velocity of flow.

a.) If the water depth is greater than 2 inches deep at the center of pipe, use the current meter.

i. Make sure the Flow Probe 's propeller turns freely by blowing strongly on the prop. Remove any debris that is caught in the propeller.
ii. Make sure the probe display shows "V" for velocity mode, "av" for averaging mode, and "mi" for English units (ft/s). If not, see the calibration section to set up the probe.
iii. Insert the propeller end of the probe into the middle of the flow you wish to measure. **Point the arrow inside the prop housing downstream**.
iv. **With the propeller placed at your measuring point in the flow, push both the right and left buttons simultaneously for approximately 1 second and then release them.** This will clear the computer and reset the average velocities. **Tell your partner at the time you reset the meter and have them tell you when 30 seconds have elapsed since the reset.** The Flow Probe uses true velocity averaging. When the average velocity is zeroed by pushing both buttons, a running average is started. As long as the probe remains in the flow, the averaging continues. One reading is taken per second, and a continuous average is displayed. For example, after 10 seconds, 10 readings are totaled and then divided by 10 and this average is displayed.
v. For small streams and pipes, the probe can be moved slowly and smoothly throughout the flow during average velocity measurement. Move the probe smoothly and evenly back and forth from top to bottom of the flow so that the probe stays at each point in the flow for approximately the same amount of time. Keep moving the probe for 30 seconds to obtain an accurate average value that accounts for surging. (Move the probe as if you were spray painting and attempting to get an even coat of paint over the entire surface.)
vi. After 30 seconds (as timed by your partner), **read the SMALLER number (the average velocity) on the lower right corner of the screen**. Have your partner record the average velocity value on the data sheet in ft/s. Do not remove the probe from the flow when you read the measurement.
vii. Repeat the velocity measurement for a total of three times.
viii. If the flow is so slow that no velocity reading is displayed, you cannot use the probe. Try to measure flow using the miniature float method (see Step 4B in below)
ix. Record the time that you completed your measurements on the field data sheet.

b.) If the water depth is less than 2 inches deep at the center of the pipe or if the velocity is too low to use the probe, use the miniature float method.

i. Place a small foam float on the end of a flat piece of wood of known length (either 4 feet or 8 feet long).
ii. Balancing the float on top of the plank, insert the plank into the culvert above the flowing water (with the float on the end inserted into the culvert first). Move the plank all the way into the culvert until the end without the float is flush with the end of the culvert.
iii. Count down out loud "3-2-1-go" and then turn the plank over to drop the float into the flow. The other team member will start a stopwatch at the time that the float is dropped. You may need to shake the rod to get the float to fall off if the pieces are wet.
iv. Watch the end of the pipe and say "stop" when the float reaches the end of the pipe. The team member with the stopwatch will stop the timer at that time. Record the time of travel for the float on the data sheet.
v. Repeat this measurement for a total of three times.
vi. On the field data sheet, circle the length of rod used for the measurement. *You should always start with the 4 foot rod because it is easier. However, if the time of travel with the 4 foot rod is less than 1 second, you should switch to the 8 foot rod.*
vii. Record the time that you completed your measurements on the field data sheet.

6. Record an comments or observations about the flow measurement in the final column of the field data sheet.

C. Quality Control/Quality Assurance:

For quality assurance purposes, duplicate analyses are required on at least ten percent (10%) of all velocity/depth measurements collected. For every 10th measurement of velocity and depth, duplicate the velocity and depth measurements and record them on the worksheet. Each field data sheet has 11 rows. The last row of every datasheet should be a duplicate measurement of the previous row.

D. Calculating Flow from Field Measurements

Stormwater flux will be calculated by the following equation:

$$Q = A \cdot V$$

Where,
Q = discharge in ft^3/sec
A = cross sectional area of the filled portion of a circular pipe, ft^2
V = velocity of flow, ft/sec

Cross sectional area of the filled portion of the circular pipe is derived from the following equation (CRC, 1974):

$$A = R^2 \cdot \cos^{-1}\left(\frac{R-h}{R}\right) - (R-h)\sqrt{\left(2Rh - h^2\right)}$$

Where
A= cross sectional area of the filled portion of the pipe, ft^2
R= radius of pipe, ft
h = depth of water in pipe, ft

Cross sectional area of the filled portion of a box culvert is:

$$A = W \cdot h$$

Where,
A= cross sectional area of the filled portion of the pipe, ft^2
W = width of box culvert at the water level, ft
h = depth of water in pipe, ft.

NHDES SHELLFISH PROGRAM
ROUTINE MONITORING QA/FIELD DATA SHEET

Run (circle 1) Great Bay Little Harbor Atl.Coast Rye Harbor
Hampton Harbor Atl. Coast (Boat) Other (specify):________________________

Funding (circle 1) DHHS NHEP DES OTHER (specify)______________

Sampling Day Info. Samples Collected by:__________________ Collection Date:____________ No. Sites Sampled:________

Air Temp (^{o}C):______ Weather Conditions: ____

Wind Direc (degrees)______ Wind Speed (circle 1) calm 0-5mph 5-10mph >10mph

Portland Low Tide Time_________ LT Height_________ Prev. HT Height_________

Chain of Custody Transported to _____________________ by _________________________ on _______________________
(name/org.) (name) (date)

Transported to _____________________ by _________________________ on _______________________
(name/org.) (name) (date)

Lab QA Delivery Date:______________ Delivery Time:_________________ Delivery Temp._______________°C

Samples acceptable? (yes/no)__________ Samples accepted by:__________________________________

If no, state problem:____

Analysis Date:____________________ Analysis Time:______________ Analysis Temp.________°C

Analyst:_________________________ Report Verifier:________ Date of Report:__________________

Analysis Method (circle one) MPN(LST-EC) MPN(A1) Plate Count

This QA sheet corresponds to and accompanies Lab #'s:_______________through____________________

Data Entry Data Entered by________________________________ Date________________

Entry Verified by_______________________________ Date________________

Entry Verified by_______________________________ Date________________

SHELLFISH GROWING WATER ANALYSES REPORT SHEET

DES Laboratories, 6 Hazen Drive, Concord, NH 03301

Station	Collect. Time	WTemp (^oC)	Lab #	FC #/100ml	Salinity (ppt)	PH	Wildlife	Other Activities
DUP								DUPLICATE OF PREVIOUS

DUP								DUPLICATE OF PREVIOUS

NH DES LABORATORY SERVICES LOGIN AND CUSTODY SHEET
(Laboratory Policy: Samples not meeting method requirements will be analyzed at the discretion of the NH DES Laboratory.)

Program / Client ID: , In-House, OSA, Pool, Special, Swim, VLAP, Other:_________ EPA # / Project #:_05-0025210__

System Name:_____ _________________ Site / Town:_ Little Harbor TMDL Study Contact:_Phil Trowbridge 271-8872_______

Comments:_ ____________________________ Collected By & Phone# ________________________________

Sample Location /ID	Date/Time Sampled	# of Containers	Matrix	FC Counts										Other / Notes	Lab ID # (For Lab Use Only)
			AQ												
			AQ												
			AQ												
			AQ												
			AQ												
			AQ												
			AQ												
			AQ												
			AQ												
			AQ												
DUP			AQ											Duplicate of Previous	

Relinquished By____________________Date and Time__________________Received By____________________

Relinquished By____________________Date and Time__________________Received By____________________

Relinquished By____________________Date and Time__________________ **Received For Laboratory By______________**

Section No.: 22.0
Revision No.: 1
Date: 1-17-01
Page 1 of 1

Matrix: A= Air S= Soil AQ= Aqueous (Ground Water, Surface Water, Drinking Water, Waste Water) ❒ Other: ____AQ____________

Page ______ of _______ Data Reviewed By_____________________________ Date______________

NHDES STORMWATER FLUX FIELD DATA SHEET

Project: Little Harbor TMDL Stormwater Monitoring **Date**:____________ **Field Team/Staff**: ______________________________

Current Meter Type and Serial #: __________________ **Data Entry by**: ______ **Entry Verified by**: _____ **Project Manager**: _____

PS#	**Time Start**	**Diam (in)**	**Depth (in)**	**Flow Measurements** *Fill in either velocity by current meter (V) or time of travel for float (T).*			**Rod Length**	**Time Stop**	**Comments**
				V= ft/s	V= ft/s	V= ft/s	N/A		
				T= s	T= s	T= s	4 ft or 8 ft		
				V= ft/s	V= ft/s	V= ft/s	N/A		
				T= s	T= s	T= s	4 ft or 8 ft		
				V= ft/s	V= ft/s	V= ft/s	N/A		
				T= s	T= s	T= s	4 ft or 8 ft		
				V= ft/s	V= ft/s	V= ft/s	N/A		
				T= s	T= s	T= s	4 ft or 8 ft		
				V= ft/s	V= ft/s	V= ft/s	N/A		
				T= s	T= s	T= s	4 ft or 8 ft		
				V= ft/s	V= ft/s	V= ft/s	N/A		
				T= s	T= s	T= s	4 ft or 8 ft		
				V= ft/s	V= ft/s	V= ft/s	N/A		
				T= s	T= s	T= s	4 ft or 8 ft		
				V= ft/s	V= ft/s	V= ft/s	N/A		
				T= s	T= s	T= s	4 ft or 8 ft		
				V= ft/s	V= ft/s	V= ft/s	N/A		
				T= s	T= s	T= s	4 ft or 8 ft		
				V= ft/s	V= ft/s	V= ft/s	N/A		
				T= s	T= s	T= s	4 ft or 8 ft		
				V= ft/s	V= ft/s	V= ft/s	N/A		Duplicate of previous reading.

				T= s	T= s	T= s	4 ft or 8 ft		

SOP for Little Harbor TMDL Sampling

Before each sampling round:

- Find the correct lab login and stormwater flux datasheets for the sampling round. These sheets are pre-prepared for all the stations you will be hitting on this round. The name of the sample round is listed in the "comments" field. There will be less stations listed on the stormwater flux sheet than on the lab login sheet because flow is not measured at all the sites. Only measure flow for the sites that are listed on the stormwater flux datasheet.
- Fill in the names of the field team members on both sheets, and the date and flow meter serial number on the stormwater flux sheet.
- Review your sites for the sampling round and plan your route. The samples are listed on the lab login sheet in the order in which you should visit them. The site name is the first part of the Sample ID. The second and third parts of the Sample ID refer to the storm event (S2= second storm) and the round (PS=prestorm, R1=run 1, etc.).

At each site:

1. Collect water sample
   a. Record the date & time (in military units) on the lab login data sheet. Label sample bottle with the Sample ID, date (mm/dd/yy) and time (military). Make sure that the Sample ID, date and time on the bottle are exactly the same as on the login sheet.
   b. Put on gloves
   c. Collect sample without stirring up sediment off the bottom.
   d. Place sample on ice in the cooler.

2. Measure flow (for sites listed on the stormwater flux datasheet)
   a. Record the time (in military units) in the second column.
   b. If the pipe is dry, record "DRY" in the comments field and then stop.
   c. If the pipe contains water but it is obviously not moving, record "STANDING WATER BUT NO FLOW" in the comments field and then stop.
   d. If there is water and flow, measure the flow.
      i. Measure the depth of water at the middle of the pipe using the depth tool. For pipes or culverts with uneven bottoms, take 3 or 4 depth measurements and record the average. *Remember to subtract the length of the wire (3 inches) when you record the depth in the depth column.*
      ii. If the diameter field contains "BOX", then measure the width of the pipe *at the waterline* using the folding yardstick. Record this value in the comments field.
      iii. If the depth is less than 2 inches, use the "float-and-stick" method to estimate the flows. If the depth is greater than 2 inches, use the current meter method to estimate the flows. Record the time or velocity values in the appropriate fields on the sheet.
      iv. If velocities are too low to measure by the current meter or if the wind or something else interferes with the float-and-stick method, record "FLOW BUT TOO LOW TO MEASURE" in the comments field. Leave the "Flow measurements" fields blank.
   e. Record the time (in military units) when you complete your measurement.

After each sampling round:

- If you did not collect samples for all the sites on the login sheet for the round, cross out the row(s) for the missing sites on the login sheet with a single line.
- Verify that all samples are labeled correctly.
- Put all the samples from the run in one plastic bag, tie the bag shut, and then put the bag in the cooler.
- Call Phil at 603-661-7561.

APPENDIX G

Data Entry and QA/QC SOP

1.0. Process

To develop data entry and QA/QC consistency across the Watershed Management Bureau for monitoring related data, the following steps will be adhered to:

1) One person enters the data into the database and writes on the program data sheet or field book page in the upper right hand corner their first initial, last name, and date data was entered into the database. The data is marked as "Initial" in the database if the column exists in the program's respective data management application. When the water quality database is built, setting the "Initial" flag will be a required element.

2) A second person (cannot be the same person who initially entered data), reviews the data entry by checking the field form against the database. This person writes their first initial, last name, and date data was reviewed below the initial data entry person's information on the field book page or program data sheet.

3) If the second person finds an obvious and clear data entry error (transposed numbers, missing data etc.), then that person can correct the data in the database.

4) If the second person finds an error that is less obvious (such as an illegible entry), then both persons will consult with the program manager or QA/QC manager for a final decision.

5) Data will be marked "Final" after it has been QA/QC'd by the second person and/or after the program manager has reviewed it.

6) Laboratory data automatically inputted into database applications will not require this type of review since the data has already been QA/QC'd by the respective labs. Periodic checks to insure the data is being transmitted correctly will be done, however.

Wet-Weather Bacterial Loading for Little Harbor TMDL
Quality Assurance Project Plan

ADDENDUM #1

June 6, 2003

Prepared by

Phil Trowbridge, Project Manager

NH Department of Environmental Services
Watershed Management Bureau

List of Items

1. Revised SOP for Little Harbor TMDL Sampling (dated 6/5/03)

2. Revised Table 2

4. Addendum to Section B1 – Phase I Sampling Locations and Schedule

5. Table of Phase I Sampling Locations

6. Figure of Phase I Sampling Locations

7. Addendum to Section B2 - SOP for bacterial indicator sampling from bridges

Item 1: SOP for Little Harbor TMDL Sampling (Version 2, 6/5/03)

Before each sampling round:

- Find the correct lab login and stormwater flux datasheets for the sampling round. These sheets are pre-prepared for all the stations you will be hitting on this round. The name of the sample round is listed in the "comments" field. There will be less stations listed on the stormwater flux sheet than on the lab login sheet because flow is not measured at all the sites. Only measure flow for the sites that are listed on the stormwater flux datasheet.
- Fill in the names of the field team members on both sheets, and the date and flow meter serial number on the stormwater flux sheet.
- Review your sites for the sampling round and plan your route. The samples are listed on the lab login sheet in the order in which you should visit them unless told otherwise.

At each site:

1. **Verify station information**
   a. Complete DES Sampling Station Identification form (only grey fields are required)
   b. Take GPS reading and include on station form
   c. Take photograph of source. Record the picture number at the top of the station form.
   d. Note whether the source is a round pipe, a channel, or some other configuration and measure dimensions. Record this informatin in the "station description" field.
2. **Collect water sample**
   a. Record the date & time (in military units) on the lab login data sheet. Label sample bottle with the Sample ID, date (mm/dd/yy) and time (military). Make sure that the Sample ID, date and time on the bottle are exactly the same as on the login sheet.
   b. Put on gloves (and goggles/mask if there is a chance of splashing)
   c. Collect sample without stirring up sediment off the bottom. If you are sampling from a bridge, follow the bridge sampling SOP.
   d. Place sample on ice in the cooler as soon as possible.
3. **Measure flow (for sites listed on the stormwater flux datasheet)**
   a. Record the time (in military units) in the second column.
   b. If the pipe is dry, record "DRY" in the comments field and then stop.
   c. If the pipe contains water but it is obviously not moving, record "STANDING WATER BUT NO FLOW" in the comments field and then stop.
   d. If there is water and flow, measure the flow.
      i. Measure the depth of water at the middle of the pipe using the depth tool. For pipes or culverts with uneven bottoms, take 3 or 4 depth measurements and record the average. *Remember to subtract the length of the wire (3 inches) when you record the depth in the depth column.*
      ii. If the source is a round pipe, measure the diameter in inches and record this on the sheet.
      iii. If the source is not a round pipe, then measure the width of the source *at the waterline* using the folding yardstick. Record this value in the comments field.
      iv. If the depth is less than 2 inches, use the "float-and-stick" method to estimate the flows. If the depth is greater than 2 inches, use the current meter method to estimate the flows. Record the time or velocity values in the appropriate fields on the sheet.
      v. If velocities are too low to measure by the current meter or if the wind or something else interferes with the float-and-stick method, record "FLOW BUT TOO LOW TO MEASURE" in the comments field. Leave the "Flow measurements" fields blank.
   e. Record the time (in military units) when you complete your measurement.

After each sampling round:

- If you did not collect samples for all the sites on the login sheet for the round, cross out the row(s) for the missing sites on the login sheet with a single line. Explain why in the comment field.
- Verify that all samples are labeled correctly.
- Put all the samples on each lab login sheet in one plastic bag and then put the bag(s) in the cooler.

Item 2: Revised Table 2

The following table should be substituted for Table 2 in the QAPP.

Table 2: Municipal contacts for Little Harbor TMDL

QAPP Recipient Name	Project Role	Organization	Telephone number and Email address
Duty Officer*	Local government liaison	Portsmouth Police Department	603-427-1500
Duty Officer	Local government liaison	New Castle Police Department	603-436-3800
Duty Officer*	Local government liaison	Rye Police Department	603-964-7450
Peter Britz	Local government liaison	Portsmouth City Environmental Planner	603-431-2006 ext. 215 plbritz@ch.cityofportsmouth.org
Peter Rice	Local government liaison	City of Portsmouth Dept of Public Works	603-766-1416 phrice@pw.cityofPortsmouth.com
David Allen	Local government liaison	City of Portsmouth Dept of Public Works	603-427-1530 603-766-1421 (mobile) Dsallen@pw.cityofportsmouth.com
John Elsden*	Local government liaison	Planning Board Town of Rye	603-964-9800 johne@town.rye.nh.us
Bud Jordan	Local government liaison	Dept. of Public Works Town of Rye	603-964-5300
Jim Raines	Local government liaison	Conservation Comm. Town of Rye	603-431-6962
Brad Meade*	Local government liaison	Dept. of Public Works Town of New Castle	603-431-6710 ext. 13
Steve Tabbutt	Local government liaison	Road Agent Town of New Castle	603-431-6710 ext. 13

* Wants to be contacted before each sampling event.

Item 3: Addendum to Section B1 – Phase I Sampling Locations and Schedule

Phase I Sampling Effort

Phase I Sampling Locations
A total of 38 stations were chosen for the Phase I sampling effort. Half of the stations are potential pollution sources (e.g., pipes, or streams/creeks that convey runoff to the estuary) from the DES Shellfish Program Shoreline Database. The other half of the stations are ambient harbor stations or ambient tributary stations used by the DES Shellfish Program and the DES Ambient Rivers Monitoring Program. All the stations for the Phase I sampling effort are listed in the attached table.

The following process was used to select the 19 pipes and streams from the DES Shellfish Program Shoreline Source database to be monitored in the Phase I sampling effort.

1. Start with Shellfish Shoreline Source database.
The database contains 99 Little Harbor Pollution Sources (LHPS) listed in categories of pipes, tidal creeks, perennial streams, and intermittent streams.

2. Perform Initial Query
Select 61 records based on:

All Tidal Creek, Intermittent Stream, and Perennial Streams
All pipes >= 12 inches
All pipes with no diameter listed
Pipes with <12 inch diameter and FC result >43 mpn/100ml.

3. Eliminate sources according to study area constraints and logistical factors.
The following is a list of the 45 sites that were eliminated for various reasons.

- 23 sites were eliminated because they were above the Route 1A Bridge over Sagamore Creek (outside of study area)
- 3 sites were eliminated because they were identified in 1999 but could not be found in 2003.
- 12 sites were collocated with other sources or were duplicate records. The source with the best access and strongest flow (as observed after a large rainstorm on 5/26/03) was chosen.
- 2 sites were eliminated because they were streams draining conservation areas (LHPS046 and LHPS036).
- 4 sites were eliminated because they were small tidal creeks draining a relatively undeveloped area next to Witch Creek. These sites were impracticable to monitor and the bacteria load from the area was expected to be small.
- 1 site was a sewage pipe that was referred to the local Health Officer. Since this pipe was not a conduit for stormwater, it was not included in the study.

4. Add 3 sources found in the 2003 surveys.

- 2 new sources were identified during the TMDL preparation.
- LHPS066 was added to the TMDL list even though it is less than 12 inches in diameter because it is collocated with another source to be monitored (LHPS050).

5. Generate list of sources for Phase I study
After the queries in steps 2, 3 and 4, there are 19 possible sources for the Phase I study. Seventeen of the sources are pipes, and two are streams/creeks.

Phase I Sampling Schedule

Phase I sampling will occur during two storms in the month of June. Two storms will be selected following the criteria listed in Section B1 of the QAPP.

- The first land team will collect one round of samples from 15 sources or tributary stations during the first three hours of each storm. The 15 stations are listed in the attached table (stations assigned to "Team 1").
- The second land team will collect one round of samples from 12 sources or tributary stations during the first three hours of each storm. The 12 stations are listed in the attached table (stations assigned to "Team 2").
- For each storm The boat team will collect one round of samples from 11 stations after approximately 3 hours of rain at or around low tide. The 11 stations are listed in the attached table (stations assigned to "Team 3").

Phase I Sampling Summary

The following table should be substituted for Table 8 in the QAPP.

Table 8: Phase I Field Sampling Summary

Parameter	No. of sampling locations	Samples per event per site	Number of sampling events	Number of field duplicates	Number of bottle blanks	Total number to lab
To be analyzed at the DES lab						
Fecal coliforms	38	1	2 rain events	10% (4/rain event)	0	84 (42/storm)
Measured in the field						
Flow	27	1	2 rain events	10% (4/rain event)	Not applicable	measured *in situ*

Based on EPA-NE Worksheet #9c.

Marina Sampling Effort

In addition to the Phase I and Phase II stormwater sampling, DES will also collect bacteria samples from the Wentworth Marina on Monday mornings during the summer season. The objective of this sampling design is to capture bacterial pollution from any boat discharges during the weekend. On each day, water samples will be taken from the end of the piers on either side of the marina and one sample will be taken from the middle of the middle pier. The field team will also count the number of boats in the slips and in the mooring field to determine whether bacteria concentrations in the marina are correlated with the number of boats in the slips. Samples will be collected on 6/9/03, 6/16/03, 6/30/03, 7/7/03, 8/11/03, and 8/18/03. The sample collection may continue into the fall if personnel and resources are available. The samples will be collected and analyzed using the procedures from Section B2, B3, and B4 of the QAPP. The results from these samples will be housed in the DES Shellfish Program shoreline database.

Item 5: Table of Phase I Sampling Locations (shown on following pages)

Item 6: Figure of Phase I Sampling Locations (shown on following pages)

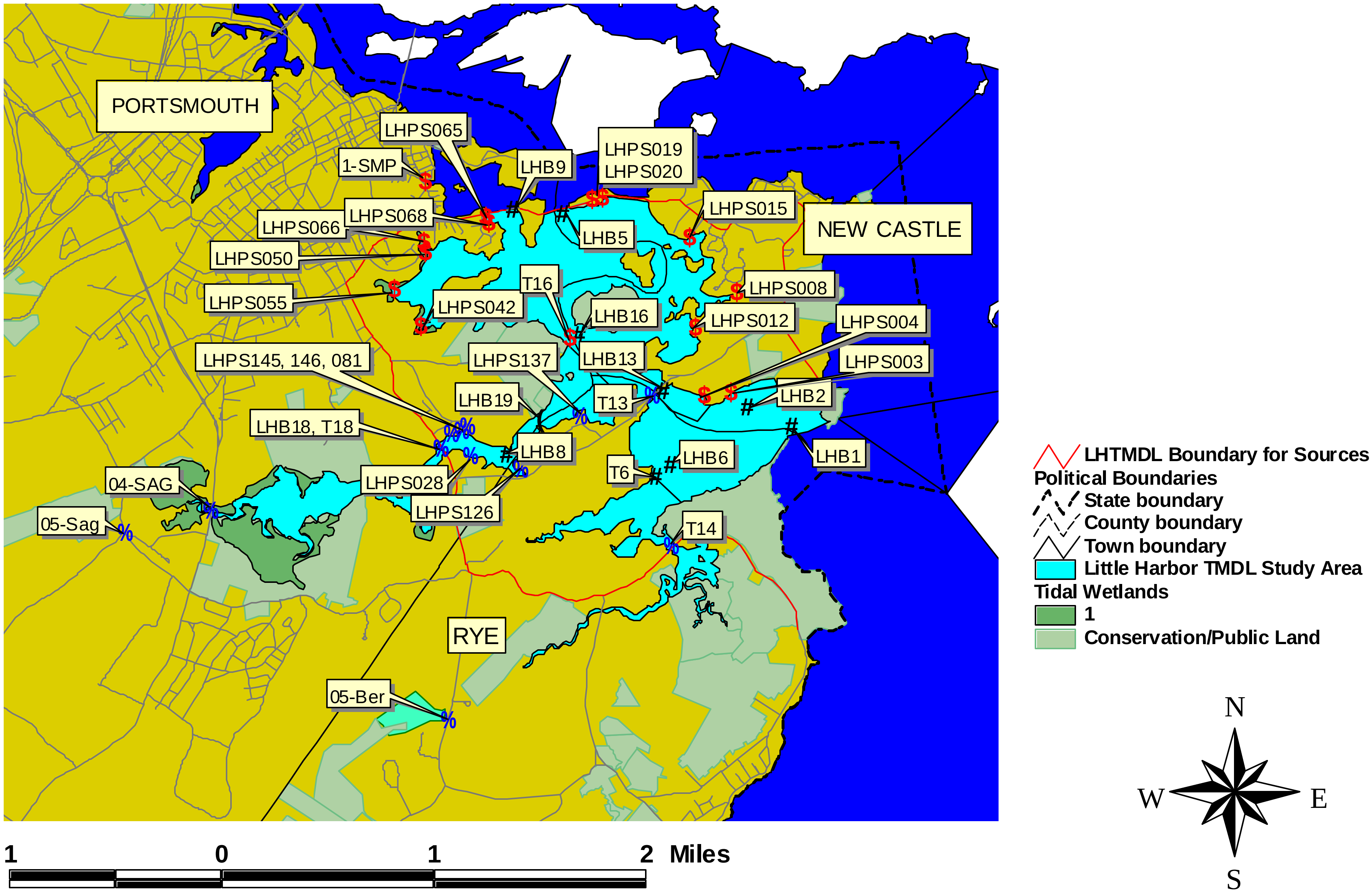
STATIONID	PROPCITY	TAXMAP	TAXLOT	LATITUDE	LONGITUDE	POTENPOLLUTION SOURCE	PIPEDIAM	POLLSOURCEDESCRIPTION	STATIONDESCRIPTION	SOURCELOCATIONONLOT	TEAM
1-SMP	PORTSMOUTH	NA	NA	43.0728	-70.7507	TIDAL CREEK	NA	OUTLET OF SOUTH MILL POND AT PLEASANT STREET BRIDGE.	UPSTREAM OF TIDE GATE FROM THE SOUTH SIDE OF THE CREEK (LEFT HAND SIDE IF YOU ARE FACING UPSTREAM).	PARK ON PLEASANT STREET BRIDGE NEAR STORE. GO OVER GUARD RAIL AND WALK TO TIDE GATE.	1
LHPS003	NEW CASTLE	2	16			PIPE	36	3' STORM DRAIN	SAMPLE AT PIPE OUTLET	PARK IN MARINA PARKING LOT. CROSS BETWEEN MARINA AND CONDO COMPLEX. CROSS ROAD AND FOLLOW FLAGSTONE PATHWAY BETWEEN HOUSES TO GET TO SOURCE NEAR THE WATER.	1
LHPS004	NEW CASTLE	2	27A	43.0581	-70.7248	PIPE	48	4 FOOT CONCRETE PIPE WITH A LARGE ROCK SITTING ACROSS THE OPENING.	SAMPLE AT PIPE OUTLET	PARK IN MARINA PARKING LOT. WALK TOWARD MARINA. JUST BEFORE YOU REACH THE SMALL BRIDGE, HEAD LEFT ONTO THE RIP RAP. GO 50 YARDS TO SOURCE, WHICH IS COVERED BY A LARGE ROCK AND IS DIRECTLY IN FRONT OF THE CONDO CLOSEST TO THE WENTWORTH MARINA.	1
LHPS008	NEW CASTLE	4	17			TIDAL CREEK	NA	"TIDAL CREEK ~12FT WIDE. NO FLOW AT TIME OF SURVEY, BUT CREEK IS WET"	SAMPLE RIGHT ABOVE THE SMALL PHRAGMITES STAND NEXT TO THE CREEK.	ACCESS FROM ABIGAIL LANE OFF OF WENTWORTH RD. (SIGN AT THE END OF THE STREET SAYS LEDGES AT GREAT ISLAND). GO TO THE END OF THE STREET AND GO THROUGH LOT 11 AT THE END OF THE CULDESAC (NO HOUSE THERE, JUST A FOUNDATION). WALK THROUGH THE DENSE WOODS TOWAR	1
LHPS012	NEW CASTLE	4	3	43.0628	-70.7254	PIPE	12	12 IN. PIPE DRAINING A SMALL WETLAND.	SAMPLE AT PIPE OUTLET	TAKE A LEFT ON THE ROAD JUST BEFORE THE WENTWORTH BY THE SEA, PARK AND WALK ALONG MARSH.	1
LHPS015	NEW CASTLE	11	26	TBD	TBD	PIPE	14	"14"" CEMENT SQUARE OUTLET FROM ROCK WALL. EMPTIES INTO SMALL STREAM WHICH FLOWS DIRECTLY INTO THE WATER. NO FLOW AT TIME OF SURVEY. ADDITIONALLY, BLACK CORRUGAGTED LAND DRAIN ID'D BY DES IN 1999."	SAMPLE AT PIPE OUTLET	TAKE LAUREL LANE TO DIRT ROAD ON THE LEFT BY TELEPHONE POLE #722 1. FOLLOW DIRT ROAD TO THE END. TAKE DIRT DRIVEWAY TOWARD CEDAR SHAKE HOUSE ON THE RIGHT. WALK ALONG THE SIDE OF THE PROPERTY WITH THE DRIVEWAY TO THE WATER. PIPE STICKS OUT OF ROCK WALL APP	1
LHPS019	NEW CASTLE	14	1	TBD	TBD	PIPE	12	"12"" CONCRETE PIPE BUILT INTO STONE WALL WHICH LINES ROAD. NO FLOW AT TIME OF SURVEY."	SAMPLE AT PIPE OUTLET	SAME LOCATION AS LHPS020 EXCEPT THIS PIPE IS ANOTHER 50 YARDS FARTHER EAST THAN LHPS020.	1
LHPS020	NEW CASTLE	14	1	TBD	TBD	PIPE	12	"12"" CONCRETE PIPE BUILT INTO STONE WALL WHICH LINES ROAD. NO FLOW AT TIME OF SURVEY."	SAMPLE AT PIPE OUTLET	PARK AT GOAT ISLAND SALTWATER FISHING ACCESS SIGN ON PORTSMOUTH AVE. WALK ALONG STONE WALL ON THE LEFT OF THIS PARKING AREA. PIPE IS LOCATEDAT THE BEGINNING OF THIS STONE WALL. OF THE TWO PIPES IN THIS AREA, LHPS020 IS THE CLOSEST TO THE PARKING AREA.	1
LHPS042	PORTSMOUTH	204	14	TBD	TBD	PIPE	36	"36" CMP WHICH RUNS UNDER CURRIER'S COVE RD. FLOWS INTO SMALL COLLECTING POOL AT PIPE OUTLET AND THEN INTO STREAM WHICH LEADS TO SITE LHPS041. PIPE IS BARELY TRICKLING."	SAMPLE AT PIPE OUTLET	FOLLOW CURRIER'S COVE RD TO ELECTRICAL BOX ON THE RIGHT. THE ELECTRICAL BOX IS LOCATED RIGHT AFTER TAN COLONIAL HOUSE AND BEFORE THE END OF THE CUL-DE-DAC. CLIMB DOWN INTO WOODS TO GET TO PIPE OUTLET.	1
LHPS050	PORTSMOUTH	206	18	TBD	TBD	PIPE	12	"12" METAL PIPE. STICKS OUT OF BANK ~2FT. BETWEEN TWO DOCKS. NO FLOW AT TIME OF SURVEY."	SAMPLE AT PIPE OUTLET	VERY CLOSE TO LHPS066. FROM LHPS066, WALK TOWARD LH SCHOOL FOR 100 YDS. YOU WILL PASS ONE DOCK ON THE WAY.	1
LHPS055	PORTSMOUTH	206	20	43.0656	-70.7535	PIPE	24	"24"" IRON PIPE, IN FRONT OF GREY HOUSE, MODERATE FLOW, GREEN FILAMENTOUS ALGAE AT OUTFALL"	SAMPLE AT PIPE OUTLET	TAKE ENTRANCE TO CEMETARY ON SOUTH STREET. GO STRAIGHT AND THEN LEFT FOLLOWING THE MAIN PATH. UNTIL YOU REACH THE WATER. PARK AND WALK NORTH THROUGH CEMETARY TOWARD LH SCHOOL TO SALT MARSH. PIPE SHOULD BE 100 YDS FROM CEMETARY BOUNDARY.	1
LHPS065	PORTSMOUTH	207	7	TBD	TBD	PIPE	12	"12"" CONCRETE PIPE, ROAD DRAIN"	SAMPLE AT PIPE OUTLET	PARK ON PLEASEANT POINT DRIVE, NEXT TO WOODED GARD RAIL. HOP RAIL AND WALK TO WATER. PIPE IS LOCATED IN AN OVERGROWN AREA WITH ROSES AND SOME BUSHES. SMALL WALL/FLOWER GARDEN BUILD AROUND OUTFALL.	1
LHPS066	PORTSMOUTH	207	70	43.0688	-70.7507	PIPE	10	"PIPE IS A 10" GREEN PVC LAND DRAIN. IT IS LOCATED AT THE BOTTOM OF A BERM AT THE BEGINING OF TIDAL DRAINAGE STREAM."	SAMPLE AT PIPE OUTLET	TAKE RIDGES CT TO THE END AND PARK. WALK DOWN TO THE SHORE AND HEAD RIGHT (WEST). FOLLOW SHORELINE BACK TO A SMALL INLET. PIPE IS LOCATED AT THE BASE OF A LARGE BERM SEPARATING THE MARSH FROM THE PROPERTY.	1

STATIONID	PROPCITY	TAXMAP	TAXLOT	LATITUDE	LONGITUDE	POTENPOLLUTION SOURCE	PIPEDIAM	POLLSOURCEDESCRIPTION	STATIONDESCRIPTION	SOURCELOCATIONONLOT	TEAM
LHPS068	PORTSMOUTH	207	8	43.0701	-70.7446	PIPE	12	"12"" ASBESTO PIPE BUILT INTO STONE WALL. STICKS OUT APPROX. 1-2FT FROM WALL. PIPE NOT FLOWING AT TIME OF SURVEY."	SAMPLE AT PIPE OUTLET	PARK ON PLEASEANT POINT DRIVE, NEXT TO WOODED GARD RAIL. HOP RAIL AND WALK TO WATER. WALK TO THE RIGHT FOR 30 YARDS. LHPS068 IS WITHIN 30 YARDS OF LHPS065. LHPS065 IS CLOSER TO ROUTE 1B THAN LHPS068.	1
T16	PORTSMOUTH	NA	NA	43.0614	-70.7378	TIDAL CREEK	NA	BACK CHANNEL NEAR GREEN CAN OFF WENTWORTH COOLIDGE MANSION	USE CHEST WADERS AND LONG SAMPLING POLE TO COLLECT SAMPLE AS CLOSE TO GREEN CAN AS POSSIBLE.	FOLLOW SIGNS TO WENTWORTH COOLIDGE MANSION. PARK IN PARKING LOT. WALK DOWN LAWN OF MANSION TO SMALL PEBBLE BEACH. USE CHEST WADERS TO WALK OUT AS CLOSE AS POSSIBLE TO THE CAN.	1

STATIONID	PROPCITY	TAXMAP	TAXLOT	LATITUDE	LONGITUDE	POTENPOLLUTION SOURCE	PIPEDIAM	POLLSOURCEDESCRIPTION	STATIONDESCRIPTION	SOURCELOCATIONONLOT	TEAM
04-SAG	PORTSMOUTH	NA	NA	TBD	TBD	TIDAL CREEK	NA	SAGAMORE CREEK FROM ROUTE 1 BRIDGE	COLLECT SAMPLE FROM BRIDGE ON THE UPSTREAM SIDE OF THE BRIDGE.	PARK IN PARKING LOT FOR NEARBY BUSINESS AND WALK TO SITE. DO NOT PARK ON BRIDGE. DO NOT ATTEMPT TO CROSS THE ROAD.	2
05-BER	RYE	NA	NA	43.0362	-70.7488	TIDAL CREEK	NA	FRESHWATER PORTION OF BERRY'S BROOK	COLLECT SAMPLE FROM BROOK UPSTREAM OF SAGAMORE ROAD. READ THE WATER HEIGHT ON THE WHITE BOARD ON THE CULVERT. RECORD THE HEIGHT ON THE LAB LOGIN SHEET.	FROM ROUTE 1A, FOLLOW SAGAMORE ROAD SOUTH UNTIL IT CROSSES BERRY'S BROOK.	2
05-SAG	PORTSMOUTH	NA	NA	43.0492	-70.7787	PERENNIAL STREAM	NA	FRESHWATER PORTION OF SAGAMORE CREEK	COLLECT SAMPLE FROM CREEK DOWNSTREAM OF PEVERLY HILL ROAD.	GO TO INTERSECTION OF PEVERLY HILL RD AND BANFIELD RD. PULL OFF IN DIRT PULL OUT. SAMPLE DOWNSTREAM OF ROADS.	2
LHPS028	PORTSMOUTH	201	4	43.0542	-70.7465	PIPE	12	"12" GREEN PVC LAND DRAIN WITH NO FLOW ON 6-9-99. CONSIDERABLE FLOW ON 4-29-03, GREEN ALGAE ON ROCKS."	SAMPLE AT PIPE OUTLET	ACESS VIA #3 SAGAMORE CIRCLE. WALK ON WEST SIDE OF LOT DOWN TO THE WATER. PIPE IS ABOUT 3 FEET UP THE BANK, HALF WAY BETWEEN TWO DOCKS. NEIGHBOR INDICATES IT IS A FAIRLY NEW STORMDRAIN PUT IN BY THE CITY. CAN SEE THE CATCH BASIN IN THE STREET.	2
LHPS081	PORTSMOUTH	223	22	TBD	TBD	PIPE	12	"12"" CMP WHICH STICKS OUT OF BANK APPROX 1FT. NO FLOW AT TIME OF SURVEY"	SAMPLE PIPE AT OUTLET	ACCESS BY #24 SHAW RD (NEIGHBORS). WALK TO SHORELINE AND THEN TRAVEL THROUGH GRASSY AREA ABOVE HWM. PIPE IS LOCATED IN COVE AND LOOKS OUT ON HOUSE #24'S PIER AND DOCK. PIPE IS COVERED BY SOME BRUSH AND RUNS PERPENDICULAR TO PINE TREES WHICH RUN ALONG THE	2
LHPS126	RYE	24	30	TBD	TBD	PIPE	14	"14"" CRACKED BLACK PRESSED CARDBOARD PIPE. RUNS UNDER WENTWORTH RD. FLOWING WITH TIDAL INFLUENCE."	SAMPLE AT PIPE OUTLET	FOLLOW WENTWORTH RD JUST PAST WITCH COVE MARINA AND BG'S BOAT HOUSE. THERE IS A NARROW COVE HERE. WOODEN POSTS LINE THE ROAD. PULL OFF HERE AND WALK INTO CORNER ON THE SAGAMORE CREEK SIDE. PIPE IS MARKED BY A METAL STAKE IN THE GROUND.	2
LHPS137	RYE	26	4	TBD	TBD	PIPE	12	"12" CAST IRON PIPE BUILT INTO ROCK WALL. NO FLOW AT TIME OF SURVEY."	SAMPLE AT PIPE OUTLET	WALK TO SHORELINE BETWEEN HOUSE # 23 AND #25. WALK TOWARD PIER ON #23'S LOT. PIPE IS LOCATED IN THE ROCK WALL LINING #23'S PROPERTY ON THE LEFT SIDE OF THE PIER NEAR THE MARSH GRASS.	2
LHPS145	PORTSMOUTH	223	20	TBD	TBD	PIPE	TBD	CULVERT UNDER WALKER BUNGALOW ROAD	SAMPLE AT DOWNSTREAM CULVERT OUTLET	TAKE LITTLE HARBOR RD. TILL YOUR FIRST LEFT WHICH IS WALKER BUNGALOW RD. ACCESS BY #220 WALKER BUNGALOW RD, 2 STORY RED HOUSE WITH EXPOSED BASEMENT, LARGE SHED, AND RED BARN. CULVERT IS RIGHT AFTER THE SHED.	2
LHPS146	PORTSMOUTH	223	22	TBD	TBD	PIPE	TBD	15-24" CMP 50 FEET FROM LHPS081. THIS SOURCE IS CLOSER TO THE RTE 1A BRIDGE THAN LHPS081	SAMPLE AT CULVERT OUTLET WHICH IS IN A THICKET OF BUSHES ABOVE A ROCK PILE.	PARK AT LOCATION FOR LHPS145. WALK DOWN STREAM AT LHPS145 TO WATER. WALK ALONG SHORE TOWARD THE RTE 1A BRIDGE. PASS UNDER 2 PIERS AND THEN TURN A CORNER TO THE RIGHT. GO ANOTHER 100 YARDS. THE SOURCE IS IN A THICKET IN THE CORNER. YOU WILL PASS LHPS081.	2
T13A	PORTSMOUTH	NA	NA	TBD	TBD	TIDAL CREEK	NA	BACK CHANNEL FROM ROUTE 1B BRIDGE	COLLECT SAMPLE FROM THE MIDDLE OF THE UPSTREAM SIDE OF BRIDGE. LOWER BOTTLE HOLDER TO WATER TO COLLECT SAMPLE.	PARK ON ROUTE 1B AT THE WEST SIDE OF THE BRIDGE. CROSS THE ROAD AND WALK ACROSS THE BRIDGE ON THE BACK CHANNEL SIDE WHERE THERE IS A SIDEWALK.	2
T14	RYE	NA	NA	43.0478	-70.7282	TIDAL CREEK	NA	BERRY'S BROOK AT ROUTE 1A WOODEN BRIDGE	COLLECT SAMPLE FROM THE MIDDLE OF THE UPSTREAM SIDE OF BRIDGE. LOWER BOTTLE HOLDER TO WATER TO COLLECT SAMPLE.	PARK IN THE DIRT PULL-OFF ON THE WEST SIDE OF THE BRIDGE.	2
T18	PORTSMOUTH	NA	NA	TBD	TBD	TIDAL CREEK	NA	SAGAMORE CREEK AT ROUTE 1A BRIDGE	SAMPLED FROM BRIDGE. COLLECT SAMPLE FROM THE MIDDLE OF THE UPSTREAM SIDE OF BRIDGE. LOWER BOTTLE HOLDER TO WATER TO COLLECT SAMPLE.	PARK IN PARKING LOT FOR SAGAMORE GENERAL STORE ON THE SOUTH SIDE OF THE BRIDGE.	2

STATIONID	PROPCITY	TAXMAP	TAXLOT	LATITUDE	LONGITUDE	POTENPOLLUTION SOURCE	PIPEDIAM	POLLSOURCEDESCRIPTION	STATIONDESCRIPTION	SOURCELOCATIONONLOT	TEAM
LHB1	NEW CASTLE	NA	NA	43.0558	-70.7169	HARBOR	NA	OFF FROST POINT JETTY AT GREEN CAN AT MOUTH OF LITTLE HARBOR	SAMPLED BY BOAT	SAMPLED BY BOAT	3
LHB13	NEW CASTLE	NA	NA	43.0583	-70.7289	HARBOR	NA	BACK CHANNEL AT ROUTE 1B BRIDGE BY WENTWORTH MARINA (DOWNSTREAM/LH SIDE)	SAMPLED BY BOAT	SAMPLED BY BOAT	3
LHB16	NEW CASTLE	NA	NA	43.0622	-70.7367	HARBOR	NA	MIDDLE OF BACK CHANNEL	SAMPLED BY BOAT	SAMPLED BY BOAT	3
LHB18	PORTSMOUTH	NA	NA	TBD	TBD	TIDAL CREEK	NA	SAGAMORE CREEK AT ROUTE 1A BRIDGE (UPSTREAM SIDE)	SAMPLED BY BOAT	SAMPLED BY BOAT	3
LHB19	PORTSMOUTH	NA	NA	TBD	TBD	TIDAL CREEK	NA	SAGAMORE CREEK NARROWS DOWNSTREAM OF WITCH COVE MARINA	SAMPLED BY BOAT.	SAMPLED BY BOAT	3
LHB2	NEW CASTLE	NA	NA	43.0572	-70.7211	HARBOR	NA	ALONG NEW CASTLE SHORELINE	SAMPLED BY BOAT	SAMPLED BY BOAT	3
LHB5	NEW CASTLE	NA	NA	43.0706	-70.7381	HARBOR	NA	BETWEEN SHAPLEIGH AND GOAT ISLANDS, NORTH EDGE OF BACK CHANNEL	SAMPLED BY BOAT	SAMPLED BY BOAT	3
LHB6	RYE	NA	NA	43.0533	-70.7283	TIDAL CREEK	NA	WITCH CREEK AT SHEAFES POINT	SAMPLED BY BOAT	SAMPLED BY BOAT	3
LHB8	PORTSMOUTH	NA	NA	43.0542	-70.7436	TIDAL CREEK	NA	WITCH COVE MARINA IN SAGAMORE CREEK	SAMPLED BY BOAT	SAMPLED BY BOAT	3
LHB9	PORTSMOUTH	NA	NA	43.0708	-70.7428	HARBOR	NA	BETWEEN SHAPLEIGH AND MAINLAND, NORTH EDGE OF BACK CHANNEL	SAMPLED BY BOAT	SAMPLED BY BOAT	3
T6	RYE	NA	NA	43.0526	-70.7298	TIDAL CREEK	NA	WITCH CREEK AT SHEAFES POINT	SAMPLE COLLECTED FROM A BOAT AS CLOSE TO SHORE AS POSSIBLE	SAMPLED BY BOAT	3

Little Harbor TMDL Study Area



Item 7: Addendum to Section B2 - SOP for bacterial indicator sampling from bridges

SOP for collecting a river sample from a bridge using a bottle holder

1. Wear protective gloves (large plastic gloves or small laboratory latex gloves), and if splashing is likely to occur, protective eyewear should also be worn.
2. Use a sterile 250-mL HDPE bottle from the DES lab to collect the sample.
3. Write the sample ID number, the date of collection, time of collection, indicator species, dilution factor and sampler's initials on a label using water proof/indelible ink.
4. Seat sample bottle in the empty PVC tube branching at 45 degrees off from the vertical tube.
5. Remove the sample cap.
6. Carefully lower apparatus to water. Apparatus should be lowered until the vane is in the water. With the bottle out of the water, allow the current to swing the vane around so the bottle is upstream of the vane.
7. Collect the sample by letting go of the rope (12-18 inches of slack), and allowing the weight of the instrument to pull the bottle under water. The bottle will fill in a few seconds. Pull it quickly all the way out of the water.
8. If the bottle does not fully submerge, haul the apparatus up to the top of the bridge, discard the used bottle, add additional weight to the apparatus, and repeat this SOP starting at Step 2 with a new sterile bottle.
9. Haul the apparatus up to the top of the bridge.
10. Replace the sample cap.
11. Place bottle in a cooler on ice as soon as possible.
12. Wipe down apparatus with a paper towel to remove contamination from waterbody.
13. Wash hands thoroughly following sampling.

Wet-Weather Bacterial Loading for Little Harbor TMDL
Quality Assurance Project Plan

ADDENDUM #1

June 6, 2003

Prepared by

Phil Trowbridge, Project Manager

NH Department of Environmental Services
Watershed Management Bureau

List of Items

1. Revised SOP for Little Harbor TMDL Sampling (dated 6/5/03)

2. Revised Table 2

4. Addendum to Section B1 – Phase I Sampling Locations and Schedule

5. Table of Phase I Sampling Locations

6. Figure of Phase I Sampling Locations

7. Addendum to Section B2 - SOP for bacterial indicator sampling from bridges

Item 1: SOP for Little Harbor TMDL Sampling (Version 2, 6/5/03)

Before each sampling round:

- Find the correct lab login and stormwater flux datasheets for the sampling round. These sheets are pre-prepared for all the stations you will be hitting on this round. The name of the sample round is listed in the "comments" field. There will be less stations listed on the stormwater flux sheet than on the lab login sheet because flow is not measured at all the sites. Only measure flow for the sites that are listed on the stormwater flux datasheet.
- Fill in the names of the field team members on both sheets, and the date and flow meter serial number on the stormwater flux sheet.
- Review your sites for the sampling round and plan your route. The samples are listed on the lab login sheet in the order in which you should visit them unless told otherwise.

At each site:

1. **Verify station information**
   a. Complete DES Sampling Station Identification form (only grey fields are required)
   b. Take GPS reading and include on station form
   c. Take photograph of source. Record the picture number at the top of the station form.
   d. Note whether the source is a round pipe, a channel, or some other configuration and measure dimensions. Record this informatin in the "station description" field.
2. **Collect water sample**
   a. Record the date & time (in military units) on the lab login data sheet. Label sample bottle with the Sample ID, date (mm/dd/yy) and time (military). Make sure that the Sample ID, date and time on the bottle are exactly the same as on the login sheet.
   b. Put on gloves (and goggles/mask if there is a chance of splashing)
   c. Collect sample without stirring up sediment off the bottom. If you are sampling from a bridge, follow the bridge sampling SOP.
   d. Place sample on ice in the cooler as soon as possible.
3. **Measure flow (for sites listed on the stormwater flux datasheet)**
   a. Record the time (in military units) in the second column.
   b. If the pipe is dry, record "DRY" in the comments field and then stop.
   c. If the pipe contains water but it is obviously not moving, record "STANDING WATER BUT NO FLOW" in the comments field and then stop.
   d. If there is water and flow, measure the flow.
      i. Measure the depth of water at the middle of the pipe using the depth tool. For pipes or culverts with uneven bottoms, take 3 or 4 depth measurements and record the average. *Remember to subtract the length of the wire (3 inches) when you record the depth in the depth column.*
      ii. If the source is a round pipe, measure the diameter in inches and record this on the sheet.
      iii. If the source is not a round pipe, then measure the width of the source *at the waterline* using the folding yardstick. Record this value in the comments field.
      iv. If the depth is less than 2 inches, use the "float-and-stick" method to estimate the flows. If the depth is greater than 2 inches, use the current meter method to estimate the flows. Record the time or velocity values in the appropriate fields on the sheet.
      v. If velocities are too low to measure by the current meter or if the wind or something else interferes with the float-and-stick method, record "FLOW BUT TOO LOW TO MEASURE" in the comments field. Leave the "Flow measurements" fields blank.
   e. Record the time (in military units) when you complete your measurement.

After each sampling round:

- If you did not collect samples for all the sites on the login sheet for the round, cross out the row(s) for the missing sites on the login sheet with a single line. Explain why in the comment field.
- Verify that all samples are labeled correctly.
- Put all the samples on each lab login sheet in one plastic bag and then put the bag(s) in the cooler.

Item 2: Revised Table 2

The following table should be substituted for Table 2 in the QAPP.

Table 2: Municipal contacts for Little Harbor TMDL

QAPP Recipient Name	Project Role	Organization	Telephone number and Email address
Duty Officer*	Local government liaison	Portsmouth Police Department	603-427-1500
Duty Officer	Local government liaison	New Castle Police Department	603-436-3800
Duty Officer*	Local government liaison	Rye Police Department	603-964-7450
Peter Britz	Local government liaison	Portsmouth City Environmental Planner	603-431-2006 ext. 215 plbritz@ch.cityofportsmouth.org
Peter Rice	Local government liaison	City of Portsmouth Dept of Public Works	603-766-1416 phrice@pw.cityofPortsmouth.com
David Allen	Local government liaison	City of Portsmouth Dept of Public Works	603-427-1530 603-766-1421 (mobile) Dsallen@pw.cityofportsmouth.com
John Elsden*	Local government liaison	Planning Board Town of Rye	603-964-9800 johne@town.rye.nh.us
Bud Jordan	Local government liaison	Dept. of Public Works Town of Rye	603-964-5300
Jim Raines	Local government liaison	Conservation Comm. Town of Rye	603-431-6962
Brad Meade*	Local government liaison	Dept. of Public Works Town of New Castle	603-431-6710 ext. 13
Steve Tabbutt	Local government liaison	Road Agent Town of New Castle	603-431-6710 ext. 13

* Wants to be contacted before each sampling event.

Item 3: Addendum to Section B1 – Phase I Sampling Locations and Schedule

Phase I Sampling Effort

Phase I Sampling Locations
A total of 38 stations were chosen for the Phase I sampling effort. Half of the stations are potential pollution sources (e.g., pipes, or streams/creeks that convey runoff to the estuary) from the DES Shellfish Program Shoreline Database. The other half of the stations are ambient harbor stations or ambient tributary stations used by the DES Shellfish Program and the DES Ambient Rivers Monitoring Program. All the stations for the Phase I sampling effort are listed in the attached table.

The following process was used to select the 19 pipes and streams from the DES Shellfish Program Shoreline Source database to be monitored in the Phase I sampling effort.

1. Start with Shellfish Shoreline Source database.
The database contains 99 Little Harbor Pollution Sources (LHPS) listed in categories of pipes, tidal creeks, perennial streams, and intermittent streams.

2. Perform Initial Query
Select 61 records based on:
All Tidal Creek, Intermittent Stream, and Perennial Streams
All pipes >= 12 inches
All pipes with no diameter listed
Pipes with <12 inch diameter and FC result >43 mpn/100ml.

3. Eliminate sources according to study area constraints and logistical factors.
The following is a list of the 45 sites that were eliminated for various reasons.

- 23 sites were eliminated because they were above the Route 1A Bridge over Sagamore Creek (outside of study area)
- 3 sites were eliminated because they were identified in 1999 but could not be found in 2003.
- 12 sites were collocated with other sources or were duplicate records. The source with the best access and strongest flow (as observed after a large rainstorm on 5/26/03) was chosen.
- 2 sites were eliminated because they were streams draining conservation areas (LHPS046 and LHPS036).
- 4 sites were eliminated because they were small tidal creeks draining a relatively undeveloped area next to Witch Creek. These sites were impracticable to monitor and the bacteria load from the area was expected to be small.
- 1 site was a sewage pipe that was referred to the local Health Officer. Since this pipe was not a conduit for stormwater, it was not included in the study.

4. Add 3 sources found in the 2003 surveys.

- 2 new sources were identified during the TMDL preparation.
- LHPS066 was added to the TMDL list even though it is less than 12 inches in diameter because it is collocated with another source to be monitored (LHPS050).

5. Generate list of sources for Phase I study
After the queries in steps 2, 3 and 4, there are 19 possible sources for the Phase I study. Seventeen of the sources are pipes, and two are streams/creeks.

Phase I Sampling Schedule

Phase I sampling will occur during two storms in the month of June. Two storms will be selected following the criteria listed in Section B1 of the QAPP.

- The first land team will collect one round of samples from 15 sources or tributary stations during the first three hours of each storm. The 15 stations are listed in the attached table (stations assigned to "Team 1").
- The second land team will collect one round of samples from 12 sources or tributary stations during the first three hours of each storm. The 12 stations are listed in the attached table (stations assigned to "Team 2").
- For each storm The boat team will collect one round of samples from 11 stations after approximately 3 hours of rain at or around low tide. The 11 stations are listed in the attached table (stations assigned to "Team 3").

Phase I Sampling Summary

The following table should be substituted for Table 8 in the QAPP.

Table 8: Phase I Field Sampling Summary

Parameter	No. of sampling locations	Samples per event per site	Number of sampling events	Number of field duplicates	Number of bottle blanks	Total number to lab
To be analyzed at the DES lab						
Fecal coliforms	38	1	2 rain events	10% (4/rain event)	0	84 (42/storm)
Measured in the field						
Flow	27	1	2 rain events	10% (4/rain event)	Not applicable	measured *in situ*

Based on EPA-NE Worksheet #9c.

Marina Sampling Effort

In addition to the Phase I and Phase II stormwater sampling, DES will also collect bacteria samples from the Wentworth Marina on Monday mornings during the summer season. The objective of this sampling design is to capture bacterial pollution from any boat discharges during the weekend. On each day, water samples will be taken from the end of the piers on either side of the marina and one sample will be taken from the middle of the middle pier. The field team will also count the number of boats in the slips and in the mooring field to determine whether bacteria concentrations in the marina are correlated with the number of boats in the slips. Samples will be collected on 6/9/03, 6/16/03, 6/30/03, 7/7/03, 8/11/03, and 8/18/03. The sample collection may continue into the fall if personnel and resources are available. The samples will be collected and analyzed using the procedures from Section B2, B3, and B4 of the QAPP. The results from these samples will be housed in the DES Shellfish Program shoreline database.

Item 5: Table of Phase I Sampling Locations (shown on following pages)

Item 6: Figure of Phase I Sampling Locations (shown on following pages)

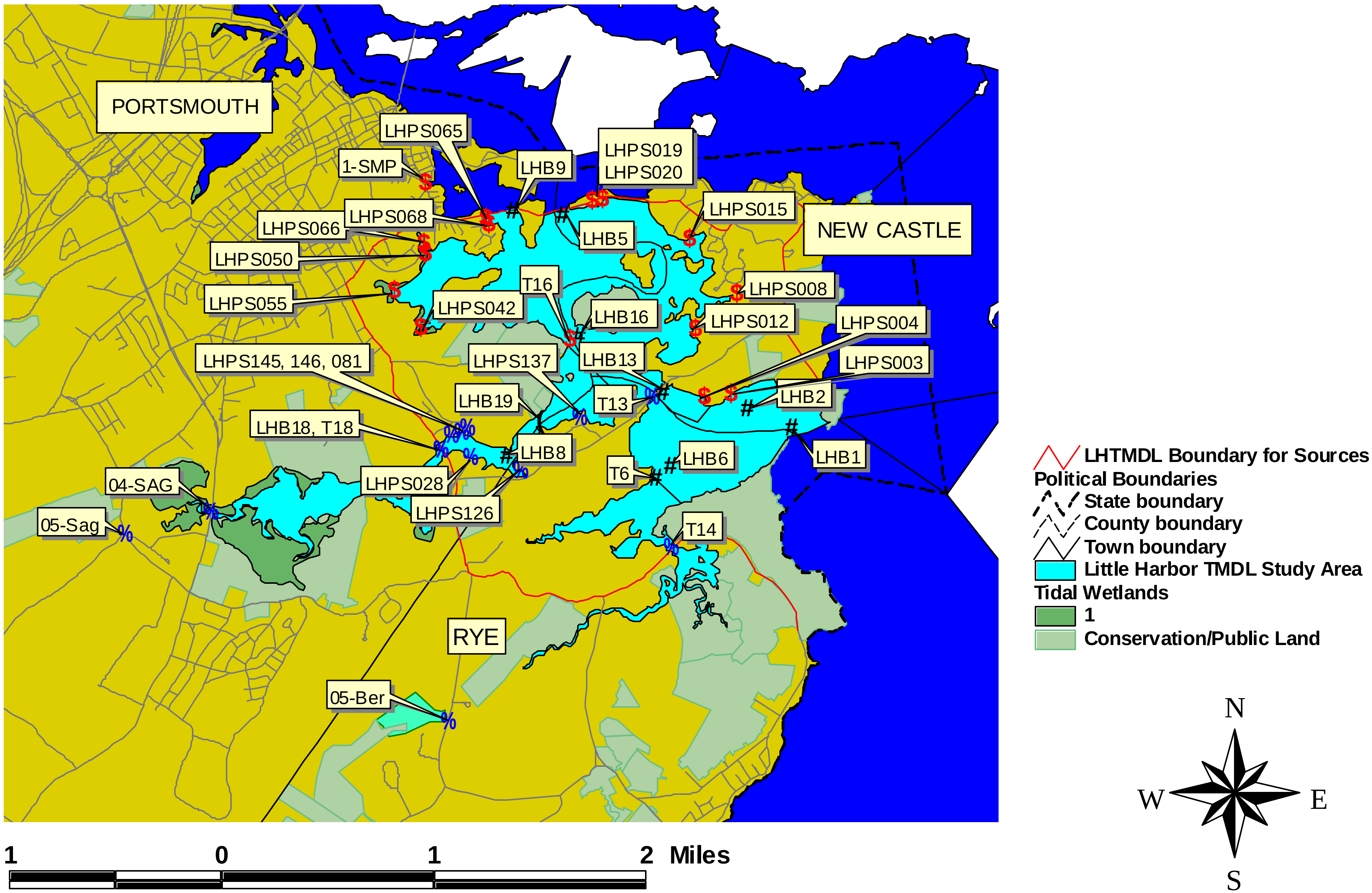
STATIONID	PROPCITY	TAXMAP	TAXLOT	LATITUDE	LONGITUDE	POTENPOLLUTION SOURCE	PIPEDIAM	POLLSOURCEDESCRIPTION	STATIONDESCRIPTION	SOURCELOCATIONONLOT	TEAM
1-SMP	PORTSMOUTH	NA	NA	43.0728	-70.7507	TIDAL CREEK	NA	OUTLET OF SOUTH MILL POND AT PLEASANT STREET BRIDGE.	UPSTREAM OF TIDE GATE FROM THE SOUTH SIDE OF THE CREEK (LEFT HAND SIDE IF YOU ARE FACING UPSTREAM).	PARK ON PLEASANT STREET BRIDGE NEAR STORE. GO OVER GUARD RAIL AND WALK TO TIDE GATE.	1
LHPS003	NEW CASTLE	2	16			PIPE	36	3' STORM DRAIN	SAMPLE AT PIPE OUTLET	PARK IN MARINA PARKING LOT. CROSS BETWEEN MARINA AND CONDO COMPLEX. CROSS ROAD AND FOLLOW FLAGSTONE PATHWAY BETWEEN HOUSES TO GET TO SOURCE NEAR THE WATER.	1
LHPS004	NEW CASTLE	2	27A	43.0581	-70.7248	PIPE	48	4 FOOT CONCRETE PIPE WITH A LARGE ROCK SITTING ACROSS THE OPENING.	SAMPLE AT PIPE OUTLET	PARK IN MARINA PARKING LOT. WALK TOWARD MARINA. JUST BEFORE YOU REACH THE SMALL BRIDGE, HEAD LEFT ONTO THE RIP RAP. GO 50 YARDS TO SOURCE, WHICH IS COVERED BY A LARGE ROCK AND IS DIRECTLY IN FRONT OF THE CONDO CLOSEST TO THE WENTWORTH MARINA.	1
LHPS008	NEW CASTLE	4	17			TIDAL CREEK	NA	"TIDAL CREEK ~12FT WIDE. NO FLOW AT TIME OF SURVEY, BUT CREEK IS WET"	SAMPLE RIGHT ABOVE THE SMALL PHRAGMITES STAND NEXT TO THE CREEK.	ACCESS FROM ABIGAIL LANE OFF OF WENTWORTH RD. (SIGN AT THE END OF THE STREET SAYS LEDGES AT GREAT ISLAND). GO TO THE END OF THE STREET AND GO THROUGH LOT 11 AT THE END OF THE CULDESAC (NO HOUSE THERE, JUST A FOUNDATION). WALK THROUGH THE DENSE WOODS TOWAR	1
LHPS012	NEW CASTLE	4	3	43.0628	-70.7254	PIPE	12	12 IN. PIPE DRAINING A SMALL WETLAND.	SAMPLE AT PIPE OUTLET	TAKE A LEFT ON THE ROAD JUST BEFORE THE WENTWORTH BY THE SEA, PARK AND WALK ALONG MARSH.	1
LHPS015	NEW CASTLE	11	26	TBD	TBD	PIPE	14	"14"" CEMENT SQUARE OUTLET FROM ROCK WALL. EMPTIES INTO SMALL STREAM WHICH FLOWS DIRECTLY INTO THE WATER. NO FLOW AT TIME OF SURVEY. ADDITIONALLY, BLACK CORRUGAGTED LAND DRAIN ID'D BY DES IN 1999."	SAMPLE AT PIPE OUTLET	TAKE LAUREL LANE TO DIRT ROAD ON THE LEFT BY TELEPHONE POLE #722 1. FOLLOW DIRT ROAD TO THE END. TAKE DIRT DRIVEWAY TOWARD CEDAR SHAKE HOUSE ON THE RIGHT. WALK ALONG THE SIDE OF THE PROPERTY WITH THE DRIVEWAY TO THE WATER. PIPE STICKS OUT OF ROCK WALL APP	1
LHPS019	NEW CASTLE	14	1	TBD	TBD	PIPE	12	"12"" CONCRETE PIPE BUILT INTO STONE WALL WHICH LINES ROAD. NO FLOW AT TIME OF SURVEY."	SAMPLE AT PIPE OUTLET	SAME LOCATION AS LHPS020 EXCEPT THIS PIPE IS ANOTHER 50 YARDS FARTHER EAST THAN LHPS020.	1
LHPS020	NEW CASTLE	14	1	TBD	TBD	PIPE	12	"12"" CONCRETE PIPE BUILT INTO STONE WALL WHICH LINES ROAD. NO FLOW AT TIME OF SURVEY."	SAMPLE AT PIPE OUTLET	PARK AT GOAT ISLAND SALTWATER FISHING ACCESS SIGN ON PORTSMOUTH AVE. WALK ALONG STONE WALL ON THE LEFT OF THIS PARKING AREA. PIPE IS LOCATEDAT THE BEGINNING OF THIS STONE WALL. OF THE TWO PIPES IN THIS AREA, LHPS020 IS THE CLOSEST TO THE PARKING AREA.	1
LHPS042	PORTSMOUTH	204	14	TBD	TBD	PIPE	36	"36" CMP WHICH RUNS UNDER CURRIER'S COVE RD. FLOWS INTO SMALL COLLECTING POOL AT PIPE OUTLET AND THEN INTO STREAM WHICH LEADS TO SITE LHPS041. PIPE IS BARELY TRICKLING."	SAMPLE AT PIPE OUTLET	FOLLOW CURRIER'S COVE RD TO ELECTRICAL BOX ON THE RIGHT. THE ELECTRICAL BOX IS LOCATED RIGHT AFTER TAN COLONIAL HOUSE AND BEFORE THE END OF THE CUL-DE-DAC. CLIMB DOWN INTO WOODS TO GET TO PIPE OUTLET.	1
LHPS050	PORTSMOUTH	206	18	TBD	TBD	PIPE	12	"12" METAL PIPE. STICKS OUT OF BANK ~2FT. BETWEEN TWO DOCKS. NO FLOW AT TIME OF SURVEY."	SAMPLE AT PIPE OUTLET	VERY CLOSE TO LHPS066. FROM LHPS066, WALK TOWARD LH SCHOOL FOR 100 YDS. YOU WILL PASS ONE DOCK ON THE WAY.	1
LHPS055	PORTSMOUTH	206	20	43.0656	-70.7535	PIPE	24	"24"" IRON PIPE, IN FRONT OF GREY HOUSE, MODERATE FLOW, GREEN FILAMENTOUS ALGAE AT OUTFALL"	SAMPLE AT PIPE OUTLET	TAKE ENTRANCE TO CEMETARY ON SOUTH STREET. GO STRAIGHT AND THEN LEFT FOLLOWING THE MAIN PATH. UNTIL YOU REACH THE WATER. PARK AND WALK NORTH THROUGH CEMETARY TOWARD LH SCHOOL TO SALT MARSH. PIPE SHOULD BE 100 YDS FROM CEMETARY BOUNDARY.	1
LHPS065	PORTSMOUTH	207	7	TBD	TBD	PIPE	12	"12"" CONCRETE PIPE, ROAD DRAIN"	SAMPLE AT PIPE OUTLET	PARK ON PLEASEANT POINT DRIVE, NEXT TO WOODED GARD RAIL. HOP RAIL AND WALK TO WATER. PIPE IS LOCATED IN AN OVERGROWN AREA WITH ROSES AND SOME BUSHES. SMALL WALL/FLOWER GARDEN BUILD AROUND OUTFALL.	1
LHPS066	PORTSMOUTH	207	70	43.0688	-70.7507	PIPE	10	"PIPE IS A 10" GREEN PVC LAND DRAIN. IT IS LOCATED AT THE BOTTOM OF A BERM AT THE BEGINING OF TIDAL DRAINAGE STREAM."	SAMPLE AT PIPE OUTLET	TAKE RIDGES CT TO THE END AND PARK. WALK DOWN TO THE SHORE AND HEAD RIGHT (WEST). FOLLOW SHORELINE BACK TO A SMALL INLET. PIPE IS LOCATED AT THE BASE OF A LARGE BERM SEPARATING THE MARSH FROM THE PROPERTY.	1

STATIONID	PROPCITY	TAXMAP	TAXLOT	LATITUDE	LONGITUDE	POTENPOLLUTION SOURCE	PIPEDIAM	POLLSOURCEDESCRIPTION	STATIONDESCRIPTION	SOURCELOCATIONONLOT	TEAM
LHPS068	PORTSMOUTH	207	8	43.0701	-70.7446	PIPE	12	"12"" ASBESTO PIPE BUILT INTO STONE WALL. STICKS OUT APPROX. 1-2FT FROM WALL. PIPE NOT FLOWING AT TIME OF SURVEY."	SAMPLE AT PIPE OUTLET	PARK ON PLEASEANT POINT DRIVE, NEXT TO WOODED GARD RAIL. HOP RAIL AND WALK TO WATER. WALK TO THE RIGHT FOR 30 YARDS. LHPS068 IS WITHIN 30 YARDS OF LHPS065. LHPS065 IS CLOSER TO ROUTE 1B THAN LHPS068.	1
T16	PORTSMOUTH	NA	NA	43.0614	-70.7378	TIDAL CREEK	NA	BACK CHANNEL NEAR GREEN CAN OFF WENTWORTH COOLIDGE MANSION	USE CHEST WADERS AND LONG SAMPLING POLE TO COLLECT SAMPLE AS CLOSE TO GREEN CAN AS POSSIBLE.	FOLLOW SIGNS TO WENTWORTH COOLIDGE MANSION. PARK IN PARKING LOT. WALK DOWN LAWN OF MANSION TO SMALL PEBBLE BEACH. USE CHEST WADERS TO WALK OUT AS CLOSE AS POSSIBLE TO THE CAN.	1

STATIONID	PROPCITY	TAXMAP	TAXLOT	LATITUDE	LONGITUDE	POTENPOLLUTION SOURCE	PIPEDIAM	POLLSOURCEDESCRIPTION	STATIONDESCRIPTION	SOURCELOCATIONONLOT	TEAM
04-SAG	PORTSMOUTH	NA	NA	TBD	TBD	TIDAL CREEK	NA	SAGAMORE CREEK FROM ROUTE 1 BRIDGE	COLLECT SAMPLE FROM BRIDGE ON THE UPSTREAM SIDE OF THE BRIDGE.	PARK IN PARKING LOT FOR NEARBY BUSINESS AND WALK TO SITE. DO NOT PARK ON BRIDGE. DO NOT ATTEMPT TO CROSS THE ROAD.	2
05-BER	RYE	NA	NA	43.0362	-70.7488	TIDAL CREEK	NA	FRESHWATER PORTION OF BERRY'S BROOK	COLLECT SAMPLE FROM BROOK UPSTREAM OF SAGAMORE ROAD. READ THE WATER HEIGHT ON THE WHITE BOARD ON THE CULVERT. RECORD THE HEIGHT ON THE LAB LOGIN SHEET.	FROM ROUTE 1A, FOLLOW SAGAMORE ROAD SOUTH UNTIL IT CROSSES BERRY'S BROOK.	2
05-SAG	PORTSMOUTH	NA	NA	43.0492	-70.7787	PERENNIAL STREAM	NA	FRESHWATER PORTION OF SAGAMORE CREEK	COLLECT SAMPLE FROM CREEK DOWNSTREAM OF PEVERLY HILL ROAD.	GO TO INTERSECTION OF PEVERLY HILL RD AND BANFIELD RD. PULL OFF IN DIRT PULL OUT. SAMPLE DOWNSTREAM OF ROADS.	2
LHPS028	PORTSMOUTH	201	4	43.0542	-70.7465	PIPE	12	"12" GREEN PVC LAND DRAIN WITH NO FLOW ON 6-9-99. CONSIDERABLE FLOW ON 4-29-03, GREEN ALGAE ON ROCKS."	SAMPLE AT PIPE OUTLET	ACESS VIA #3 SAGAMORE CIRCLE. WALK ON WEST SIDE OF LOT DOWN TO THE WATER. PIPE IS ABOUT 3 FEET UP THE BANK, HALF WAY BETWEEN TWO DOCKS. NEIGHBOR INDICATES IT IS A FAIRLY NEW STORMDRAIN PUT IN BY THE CITY. CAN SEE THE CATCH BASIN IN THE STREET.	2
LHPS081	PORTSMOUTH	223	22	TBD	TBD	PIPE	12	"12"" CMP WHICH STICKS OUT OF BANK APPROX 1FT. NO FLOW AT TIME OF SURVEY"	SAMPLE PIPE AT OUTLET	ACCESS BY #24 SHAW RD (NEIGHBORS). WALK TO SHORELINE AND THEN TRAVEL THROUGH GRASSY AREA ABOVE HWM. PIPE IS LOCATED IN COVE AND LOOKS OUT ON HOUSE #24'S PIER AND DOCK. PIPE IS COVERED BY SOME BRUSH AND RUNS PERPENDICULAR TO PINE TREES WHICH RUN ALONG THE	2
LHPS126	RYE	24	30	TBD	TBD	PIPE	14	"14"" CRACKED BLACK PRESSED CARDBOARD PIPE. RUNS UNDER WENTWORTH RD. FLOWING WITH TIDAL INFLUENCE."	SAMPLE AT PIPE OUTLET	FOLLOW WENTWORTH RD JUST PAST WITCH COVE MARINA AND BG'S BOAT HOUSE. THERE IS A NARROW COVE HERE. WOODEN POSTS LINE THE ROAD. PULL OFF HERE AND WALK INTO CORNER ON THE SAGAMORE CREEK SIDE. PIPE IS MARKED BY A METAL STAKE IN THE GROUND.	2
LHPS137	RYE	26	4	TBD	TBD	PIPE	12	"12" CAST IRON PIPE BUILT INTO ROCK WALL. NO FLOW AT TIME OF SURVEY."	SAMPLE AT PIPE OUTLET	WALK TO SHORELINE BETWEEN HOUSE # 23 AND #25. WALK TOWARD PIER ON #23'S LOT. PIPE IS LOCATED IN THE ROCK WALL LINING #23'S PROPERTY ON THE LEFT SIDE OF THE PIER NEAR THE MARSH GRASS.	2
LHPS145	PORTSMOUTH	223	20	TBD	TBD	PIPE	TBD	CULVERT UNDER WALKER BUNGALOW ROAD	SAMPLE AT DOWNSTREAM CULVERT OUTLET	TAKE LITTLE HARBOR RD. TILL YOUR FIRST LEFT WHICH IS WALKER BUNGALOW RD. ACCESS BY #220 WALKER BUNGALOW RD, 2 STORY RED HOUSE WITH EXPOSED BASEMENT, LARGE SHED, AND RED BARN. CULVERT IS RIGHT AFTER THE SHED.	2
LHPS146	PORTSMOUTH	223	22	TBD	TBD	PIPE	TBD	15-24" CMP 50 FEET FROM LHPS081. THIS SOURCE IS CLOSER TO THE RTE 1A BRIDGE THAN LHPS081	SAMPLE AT CULVERT OUTLET WHICH IS IN A THICKET OF BUSHES ABOVE A ROCK PILE.	PARK AT LOCATION FOR LHPS145. WALK DOWN STREAM AT LHPS145 TO WATER. WALK ALONG SHORE TOWARD THE RTE 1A BRIDGE. PASS UNDER 2 PIERS AND THEN TURN A CORNER TO THE RIGHT. GO ANOTHER 100 YARDS. THE SOURCE IS IN A THICKET IN THE CORNER. YOU WILL PASS LHPS081.	2
T13A	PORTSMOUTH	NA	NA	TBD	TBD	TIDAL CREEK	NA	BACK CHANNEL FROM ROUTE 1B BRIDGE	COLLECT SAMPLE FROM THE MIDDLE OF THE UPSTREAM SIDE OF BRIDGE. LOWER BOTTLE HOLDER TO WATER TO COLLECT SAMPLE.	PARK ON ROUTE 1B AT THE WEST SIDE OF THE BRIDGE. CROSS THE ROAD AND WALK ACROSS THE BRIDGE ON THE BACK CHANNEL SIDE WHERE THERE IS A SIDEWALK.	2
T14	RYE	NA	NA	43.0478	-70.7282	TIDAL CREEK	NA	BERRY'S BROOK AT ROUTE 1A WOODEN BRIDGE	COLLECT SAMPLE FROM THE MIDDLE OF THE UPSTREAM SIDE OF BRIDGE. LOWER BOTTLE HOLDER TO WATER TO COLLECT SAMPLE.	PARK IN THE DIRT PULL-OFF ON THE WEST SIDE OF THE BRIDGE.	2
T18	PORTSMOUTH	NA	NA	TBD	TBD	TIDAL CREEK	NA	SAGAMORE CREEK AT ROUTE 1A BRIDGE	SAMPLED FROM BRIDGE. COLLECT SAMPLE FROM THE MIDDLE OF THE UPSTREAM SIDE OF BRIDGE. LOWER BOTTLE HOLDER TO WATER TO COLLECT SAMPLE.	PARK IN PARKING LOT FOR SAGAMORE GENERAL STORE ON THE SOUTH SIDE OF THE BRIDGE.	2

STATIONID	PROPCITY	TAXMAP	TAXLOT	LATITUDE	LONGITUDE	POTENPOLLUTION SOURCE	PIPEDIAM	POLLSOURCEDESCRIPTION	STATIONDESCRIPTION	SOURCELOCATIONONLOT	TEAM
LHB1	NEW CASTLE	NA	NA	43.0558	-70.7169	HARBOR	NA	OFF FROST POINT JETTY AT GREEN CAN AT MOUTH OF LITTLE HARBOR	SAMPLED BY BOAT	SAMPLED BY BOAT	3
LHB13	NEW CASTLE	NA	NA	43.0583	-70.7289	HARBOR	NA	BACK CHANNEL AT ROUTE 1B BRIDGE BY WENTWORTH MARINA (DOWNSTREAM/LH SIDE)	SAMPLED BY BOAT	SAMPLED BY BOAT	3
LHB16	NEW CASTLE	NA	NA	43.0622	-70.7367	HARBOR	NA	MIDDLE OF BACK CHANNEL	SAMPLED BY BOAT	SAMPLED BY BOAT	3
LHB18	PORTSMOUTH	NA	NA	TBD	TBD	TIDAL CREEK	NA	SAGAMORE CREEK AT ROUTE 1A BRIDGE (UPSTREAM SIDE)	SAMPLED BY BOAT	SAMPLED BY BOAT	3
LHB19	PORTSMOUTH	NA	NA	TBD	TBD	TIDAL CREEK	NA	SAGAMORE CREEK NARROWS DOWNSTREAM OF WITCH COVE MARINA	SAMPLED BY BOAT.	SAMPLED BY BOAT	3
LHB2	NEW CASTLE	NA	NA	43.0572	-70.7211	HARBOR	NA	ALONG NEW CASTLE SHORELINE	SAMPLED BY BOAT	SAMPLED BY BOAT	3
LHB5	NEW CASTLE	NA	NA	43.0706	-70.7381	HARBOR	NA	BETWEEN SHAPLEIGH AND GOAT ISLANDS, NORTH EDGE OF BACK CHANNEL	SAMPLED BY BOAT	SAMPLED BY BOAT	3
LHB6	RYE	NA	NA	43.0533	-70.7283	TIDAL CREEK	NA	WITCH CREEK AT SHEAFES POINT	SAMPLED BY BOAT	SAMPLED BY BOAT	3
LHB8	PORTSMOUTH	NA	NA	43.0542	-70.7436	TIDAL CREEK	NA	WITCH COVE MARINA IN SAGAMORE CREEK	SAMPLED BY BOAT	SAMPLED BY BOAT	3
LHB9	PORTSMOUTH	NA	NA	43.0708	-70.7428	HARBOR	NA	BETWEEN SHAPLEIGH AND MAINLAND, NORTH EDGE OF BACK CHANNEL	SAMPLED BY BOAT	SAMPLED BY BOAT	3
T6	RYE	NA	NA	43.0526	-70.7298	TIDAL CREEK	NA	WITCH CREEK AT SHEAFES POINT	SAMPLE COLLECTED FROM A BOAT AS CLOSE TO SHORE AS POSSIBLE	SAMPLED BY BOAT	3

Little Harbor TMDL Study Area



Item 7: Addendum to Section B2 - SOP for bacterial indicator sampling from bridges

SOP for collecting a river sample from a bridge using a bottle holder

1. Wear protective gloves (large plastic gloves or small laboratory latex gloves), and if splashing is likely to occur, protective eyewear should also be worn.
2. Use a sterile 250-mL HDPE bottle from the DES lab to collect the sample.
3. Write the sample ID number, the date of collection, time of collection, indicator species, dilution factor and sampler's initials on a label using water proof/indelible ink.
4. Seat sample bottle in the empty PVC tube branching at 45 degrees off from the vertical tube.
5. Remove the sample cap.
6. Carefully lower apparatus to water. Apparatus should be lowered until the vane is in the water. With the bottle out of the water, allow the current to swing the vane around so the bottle is upstream of the vane.
7. Collect the sample by letting go of the rope (12-18 inches of slack), and allowing the weight of the instrument to pull the bottle under water. The bottle will fill in a few seconds. Pull it quickly all the way out of the water.
8. If the bottle does not fully submerge, haul the apparatus up to the top of the bridge, discard the used bottle, add additional weight to the apparatus, and repeat this SOP starting at Step 2 with a new sterile bottle.
9. Haul the apparatus up to the top of the bridge.
10. Replace the sample cap.
11. Place bottle in a cooler on ice as soon as possible.
12. Wipe down apparatus with a paper towel to remove contamination from waterbody.
13. Wash hands thoroughly following sampling.

Wet-Weather Bacterial Loading for Little Harbor TMDL
Quality Assurance Project Plan

ADDENDUM #2

August 4, 2003

Prepared by

Phil Trowbridge, Project Manager

NH Department of Environmental Services
Watershed Management Bureau

<u>List of Items</u>

1. Revised SOP for Little Harbor TMDL Sampling (dated 7/25/03)

2. Revised Table 2

3. Revised Descriptions and Photos of Stations

Item 1: SOP for Little Harbor TMDL Sampling (Version 3, 7/25/03)

Before each sampling round:

- Find the correct lab login and stormwater flux datasheets for the sampling round. These sheets are pre-prepared for all the stations you will be hitting on this round. The name of the sample round is listed in the "comments" field. There will be less stations listed on the stormwater flux sheet than on the lab login sheet because flow is not measured at all the sites. Only measure flow for the sites that are listed on the stormwater flux datasheet.
- Fill in the names of the field team members on both sheets, and the date and flow meter serial number on the stormwater flux sheet.

At each site:

1. **Collect water sample**
   a. Record the date & time (in military units) on the lab login data sheet. Label sample bottle with the Sample ID, date (mm/dd/yy) and time (military). Make sure that the Sample ID, date and time on the bottle are exactly the same as on the login sheet.
   b. Put on gloves (and goggles/mask if there is a chance of splashing)
   c. Collect sample without stirring up sediment off the bottom. If you are sampling from a bridge, follow the bridge sampling SOP.
   d. Place sample on ice in the cooler as soon as possible.
2. **Measure flow (for sites listed on the stormwater flux datasheet)**
   a. Record the time (in military units) in the second column.
   b. If the pipe is dry, record "DRY" in the comments field and then stop.
   c. If the pipe contains water but it is obviously not moving, record "STANDING WATER BUT NO FLOW" in the comments field and then stop.
   d. If there is water and flow, measure the flow.
      i. Measure the depth of water at the middle of the pipe using the depth tool. For pipes or culverts with uneven bottoms, take 3 or 4 depth measurements and record the average. *Remember to subtract the length of the wire (3 inches) when you record the depth in the depth column.*
      ii. If the source is a round pipe, measure the diameter in inches and record this on the sheet.
      iii. If the source is not a round pipe, then measure the width of the source *at the waterline* using the folding yardstick. Record this value in the comments field.
      iv. If the depth is less than 2 inches, use the "float-and-stick" method to estimate the flows. If the depth is greater than 2 inches, use the current meter method to estimate the flows. Record the time or velocity values in the appropriate fields on the sheet.
      v. If velocities are too low to measure by the current meter or if the wind or something else interferes with the float-and-stick method, record "FLOW BUT TOO LOW TO MEASURE" in the comments field. Leave the "Flow measurements" fields blank.
   e. Record the time (in military units) when you complete your measurement.

After each sampling round:

- If you did not collect samples for all the sites on the login sheet for the round, cross out the row(s) for the missing sites on the login sheet with a single line. Explain why in the comment field.
- Verify that all samples are labeled correctly.
- Put all the samples on each lab login sheet in one plastic bag and then put the bag(s) in the cooler.
- Call Phil at 603-661-7561

Item 2: Revised Table 2

The following table should be substituted for Table 2 in the QAPP.

Table 2: Municipal contacts for Little Harbor TMDL

QAPP Recipient Name	Project Role	Organization	Telephone number and Email address
Duty Officer	Local government liaison	Portsmouth Police Department	603-427-1500
Duty Officer	Local government liaison	New Castle Police Department	603-436-3800
Duty Officer	Local government liaison	Rye Police Department	603-964-7450
Peter Britz	Local government liaison	Portsmouth City Environmental Planner	603-431-2006 ext. 215 plbritz@ch.cityofportsmouth.com
Peter Rice*	Local government liaison	City of Portsmouth Dept of Public Works	603-766-1416 phrice@pw.cityofportsmouth.com
John Elsden*	Local government liaison	Planning Board Town of Rye	603-964-9800 johne@town.rye.nh.us
Susan Zarlengo*	Local government liaison	Building Inspector Town of Rye	susanw@town.rye.nh.us
Bud Jordan	Local government liaison	Dept. of Public Works Town of Rye	603-964-5300
Jim Raines	Local government liaison	Conservation Comm. Town of Rye	603-431-6962
Brad Meade*	Local government liaison	Dept. of Public Works Town of New Castle	603-431-6710 ext. 13
Steve Tabbutt	Local government liaison	Road Agent Town of New Castle	603-431-6710 ext. 13
Pat Kelly*	Marina liaison	Wentworth By the Sea Marina	603-433-5050
Gary Rumph*	Condo Association liaison	WBTS Master Assoc. POB 246 New Castle NH 03854	603-433-5000
Debra Godfrey*	Homeowner at LHPS008	Abigail Lane New Castle NH 03854	603-334-6320
Pauline Elton	Homeowner	149 Little Harbor Rd New Castle NH 03854	Wants final report sent to Gary Rumph.

* Wants to be contacted before each sampling event.

StationID	**04-SAG**
Town	PORTSMOUTH
Station Description	SAGAMORE CREEK FROM ROUTE 1 BRIDGE. COLLECT SAMPLE FROM MIDDLE OF THE UPSTREAM (WESTERN) SIDE OF THE BRIDGE. LOWER SAMPLE BOTTLE TO THE WATER USING BRIDGE SAMPLING APPARATUS.
Directions to Station	DRIVE WEST ON PEVERLY HILL RD. GO LEFT AT INTERSECTION WITH RTE 1. IMMEDIATELY TURN LEFT AND PARK IN LOT FOR "BRATSKELLAR". WALK IN BREAKDOWN LANE TO MIDDLE OF BRIDGE. DO NOT PARK ON BRIDGE. DO NOT ATTEMPT TO CROSS THE ROAD.
Latitude	43 3' 3" N
Longitude	-70 46' 15" W

StationID	**05-SAG**
Town	PORTSMOUTH
StationDescr	TWO OR THREE CULVERTS PASS UNDER PEVERLY HILL ROAD. TAKE SAMPLE DOWNSTREAM OF THESE CULVERTS AT THE POINT WHERE THE FLOWS FROM ALL CULVERTS COMBINE TO FORM A NARROW STREAM. COLLECT SAMPLE FROM THE MIDDLE OF THE STREAM USING A SAMPLING POLE.
Directions to	HEAD SOUTH ON ROUTE 1 IN PORTSMOUTH. GO RIGHT ONTO PEVERLY HILL ROAD. GO 1/4 MILE TO NEXT NTERSECTION. TURN RIGHT AND THEN TAKE IMMEDIATE LEFT INTO PARKING AREA FOR A GLASS BUSINESS. DRIVE TO END OF PARKING LOT. WALK ACROSS GRASS TO STREAM.
Latitude	43 2' 57" N
Longitude	-70 46' 43" W

StationID	**05-BER**
Town	RYE
StationDescr	UPSTREAM SIDE OF BRIDGE OVER BERRYS BROOK ON SAGAMORE AVENUE. FACING UPSTREAM, TAKE SAMPLE FROM THE RIGHT BANK (OPPOSITE SIDE FROM STREAM GAGE). RECORD WATER HEIGHT ON USGS GAGE INSTALLED ON BRIDGE.
Directions to	TAKE ROUTE 1A FROM PORTSMOUTH TOWARD ODIORNE STATE PARK. AT FOYES CORNER, TURN RIGHT ONTO SAGAMORE AVENUE. GO 3/4 MILE UNTIL SAGAMORE AVENUE CROSSES BERRYS BROOK. PARK IN PULL-OUT ON RIGHT SIDE OF ROAD BEFORE THE BRIDGE.
Latitude	43 2' 11" N
Longitude	-70 44' 56" W

StationID	**1-SMP**
Town	PORTSMOUTH
StationDescr	OUTFLOW OF SOUTH MILL POND AT MARCY STREET IN PORTSMOUTH.
Directions to	PARK IN FRONT OF "THE OLD FISH MARKET" STORE. CROSS ROAD TO THE SIDE CLOSEST TO SOUTH MILL POND. GO OVER GUARD RAIL TO THE LEFT OF THE OUTLET (FACING UPSTREAM). USE LONG SAMPLING POLE TO COLLECT SAMPLE FROM MIDDLE OF FLOW RUNNING THROUGH TIDE GATE.
Latitude	43 4' 21.09" N
Longitude	-70 45' 2.2" W

StationID	**LHPS003**
Town	NEW CASTLE
StationDescr	36 INCH CONCRETE STORM DRAIN. BASE IS FULL OF SAND.
Directions to	FROM RTE 1B, TAKE LITTLE HARBOR RD. PARK ON DRIVEWAY (NOT GRASS) BETWEEN #133 AND #149 ACROSS FROM UTILITY BOX "T7". HEAD SOUTH TOWARD WATER ALONG FLAGSTONE WALKWAY BETWEEN TWO HOUSES. PIPE IS LOCATED AT END OF WALKWAY.
Latitude	43 3' 29.22" N
Longitude	-70 43' 21.72" W

StationID	**LHPS004**
Town	NEW CASTLE
StationDescr	LARGE CONCRETE PIPE (36 INCHES) SET IN ROCK WALL AND COVERED BY A ROCK SLAB. DIFFICULT TO SEE. LOCATED AT MID-HIGH TIDE LINE.
Directions to	PARK IN WENTWORTH MARINA LOT. WALK TOWARD MARINA. BEFORE CROSSING SMALL WOODEN BRIDGE, GO TO THE LEFT OF THE BRIDGE ONTO THE ROCK PILE. HEAD LEFT FOR 50 FEET. THE PIPE IS AT THE BASE OF THE ROCK WALL AND IS DIRECTLY IN FRONT OF THE CLOSEST CONDO.
Latitude	43 3' 29.2" N
Longitude	-70 43' 28.3" W

StationID	LHPS008
Town	NEW CASTLE
StationDescr	TIDAL CREEK 3-6 FEET WIDE. DRAINS LARGE TIDAL MARSH IN THE MIDDLE OF NEW CASTLE ISLAND. SAMPLE AT NARROW CHANNEL WITH ROCK EXPOSED AT LOW TIDE WHICH IS JUST DOWNSTREAM OF THE PHRAGMITES STAND IN FRONT OF BEIGE HOUSE. CALL FOR PERMISSION 603-334-6320.
Directions to	TAKE ABIGAIL LANE OFF RTE 1B. DRIVE TO END OF CUL-DE-SAC. WALK AROUND THE RIGHT SIDE OF BEIGE HOUSE. FOLLOW STONE WALK WAYS ACROSS LAWN OF BEIGE HOUSE AND THEN DOWN TO MARSH. GO LEFT AT END OF WALKWAY TO GO AROUND PHRAGMITES.
Latitude	43 3' 56" N
Longitude	-70 43' 16" W

StationID	LHPS028
Town	PORTSMOUTH
StationDescr	12 INCH GREEN PVC PIPE SET INTO ROCKY BANK NEAR HIGH TIDE LINE.
Directions to	ACCESS VIA #3 SAGAMORE CIRCLE. WALK ON WEST SIDE OF LOT DOWN TO WATER. PIPE IS 3 FEET UP THE BANK, HALF WAY BETWEEN TWO DOCKS. NEIGHBOR REPORTS THAT IT IS A NEW DRAIN INSTALLED BY THE CITY. DRAINS CATCHBASIN AND WETLAND NEAR #3 SAGAMORE CIRCLE.
Latitude	43 3' 15.06" N
Longitude	-70 44' 47.34" W

StationID	LHPS042
Town	PORTSMOUTH
StationDescr	SMALL STREAM THAT DRAINS EAST SIDE OF PORTSMOUTH. SAMPLE AT OUTLET OF 36 INCH CULVERT THAT PASSES UNDER CURRIER COVE ROAD. TAKE SAMPLE AND MEASURE FLOW FROM CASCADE OVER THE LIP OF THE CULVERT.
Directions to	FOLLOW CURRIER COVE RD UNTIL YOU SEE AN ELECTRICAL BOX SURROUNDED BY CEDAR TREES ON THE RIGHT. THE UTILITY BOX IS AFTER A TAN COLONIAL HOUSE AND BEFORE THE END OF THE CUL-DE-SAC. WALK INTO BRUSH TO THE LEFT OF THE UTILITY BOX AND TURN RIGHT.
Latitude	43 3' 45.42" N
Longitude	-70 45' 5.76" W

StationID	**LHPS055**
Town	PORTSMOUTH
StationDescr	16 INCH CONCRETE, SEGMENTED PIPE. LOCATED AT MID-TIDE LINE. HALF BURIED IN SEDIMENT. COVERED WITH SEAWEED. PIPE BROKEN AT END.
Directions to	ENTER CEMETARY FROM SOUTH STREET. GO STRAIGHT THEN LEFT FOLLOWING MAIN PATH. PARK AT TURN AROUND LOOP. WALK NORTH ACROSS CEMETARY TOWARD LH SCHOOL. PASS THROUGH BUSHES NEAR "CLARK" GRAVE. WALK 100 FT ACROSS MARSH. PIPE IS NEAR OLD TIRE IN MUD.
Latitude	43 3' 56.1" N
Longitude	-70 45' 12.66" W

StationID	**LHPS065**
Town	PORTSMOUTH
StationDescr	12 INCH CONCRETE PIPE SET INTO A ROCK WALL AND SURROUNDED BY ROSE BUSHES. PIPE IS HALF FULL OF SEDIMENT. PIPE IS LOCATED AT HIGH TIDE LINE. PIPE JUST DRAINS ONE CATCH BASIN ON PLEASANT POINT ROAD.
Directions to	PARK ACROSS FROM 4 PLEASANT POINT DRIVE NEXT TO WOODEN GUARD RAIL. HOP GUARD RAIL AND DOWN SMALL ROCK RETAINING WALL. THE PIPE IS SET AT THE BOTTOM OF THE WALL DIRECTLY ACROSS FROM CATCH BASIN IN FRONT OF 4 PLEASANT POINT DRIVE.
Latitude	43 4' 13.8" N
Longitude	-70 44' 41.8" W

StationID	**LHPS068**
Town	PORTSMOUTH
StationDescr	12 INCH ASBESTOS PIPE BUILT INTO STONE RETAINING WALL. PIPE LOCATED AT THE HIGH TIDE LINE.
Directions to	PARK ACROSS FROM 4 PLEASANT POINT DRIVE NEXT TO WOODEN GUARD RAIL (SAME PLACE AS FOR LHPS065). HOP GUARD RAIL, FACE WATER, AND WALK RIGHT FOR 100 FEET. YOU WILL WALK AROUND A SMALL POINT BEFORE REACHING THE PIPE.
Latitude	43 4' 12.24" N
Longitude	-70 44' 40.5" W

StationID	LHPS081
Town	PORTSMOUTH
StationDescr	12 INCH METAL PIPE WHICH STICKS OUT OF MIDDLE OF BANK APPROXIMATELY 1 FOOT. ONLY ACCESSIBLE AT LOW TIDE.
Directions to	PARK AT CULVERT AT 220 WALKER BUNGALOW RD (LHPS145). WALK DOWN STREAM TO SHORELINE. WALK RIGHT FOR 200 FEET PASSING BENEATH TWO DOCKS AND AROUND A CORNER TO THE RIGHT. PIPE WILL BE ON YOUR RIGHT BEFORE YOU REACH THE NEXT BEND IN THE SHORELINE TO THE LEFT.
Latitude	43 3' 21" N
Longitude	-70 44' 54" W

StationID	LHPS126
Town	RYE
StationDescr	14 INCH CULVERT THAT RUNS UNDER WENTWORTH ROAD. PIPE INDUNDATED AT FROM MID-TIDE TO HIGH TIDE.
Directions to	FOLLOW WENTWORTH RD (RTE 1B) TOWARD NEWCASTLE. JUST PAST WITCH COVE MARINA AND BG'S BOAT HOUSE, THERE IS A NARROW COVE WITH A DIRT PULLOUT ON THE RIGHT (SOUTH) SIDE. PARK IN THE PULLOUT AND CROSS RD. PIPE IS LOCATED AT HEAD OF COVE. MARKED BY METAL STAKE.
Latitude	43 3' 10.86" N
Longitude	-70 44' 26.88" W

StationID	LHPS137
Town	RYE
StationDescr	12 INCH CAST IRON PIPE BUILT IN BASE OF ROCK WALL.
Directions to	TAKE ROUTE 1B TO HARBORVIEW DRIVE. WALK TO SHORELINE BETWEEN #23 AND #29 HARBORVIEW DRIVE. WALK TOWARD PIER ON #23'S LOT. PIPE IS LOCATED IN THE ROCK WALL LINING #23'S PROPERTY ON THE LEFT SIDE OF THE PIER NEAR THE MARSH GRASS.
Latitude	43 3' 25.14" N
Longitude	-70 44' 10.98" W

StationID	LHPS145
Town	PORTSMOUTH
StationDescr	10 INCH CULVERT UNDER WALKER BUNGALOW ROAD. SAMPLE AT DOWNSTREAM CULVERT OUTLET.
Directions to	TAKE LITTLE HARBOR ROAD UNTIL YOUR FIRST LEFT WHICH IS WALKER BUNGALOW ROAD. ACCESS BY #220 WALKER BUNGALOW ROAD, 2 STORY RED HOUSE WITH EXPOSED BASEMENT, LARGE SHED, AND RED BARN. CULVERT IS RIGH AFTER THE SHED.
Latitude	43 3' 22" N
Longitude	-70 44' 48" W

StationID	LHPS146
Town	PORTSMOUTH
StationDescr	15" CMP 50 FEET FROM LHPS081. THIS SOURCE TO THE RIGHT OF THE GREY HOUSE AND THE LEFT OF LHPS081. SAMPLE AT CULVERT OUTLET WHICH IS IN A THICKET OF ROSE BUSHES ABOVE A ROCK PILE. THE PIPE IS NOT VISIBLE. NOT POSSIBLE TO MEASURE FLOW BECAUSE OF ROSE BUSHES
Directions to	PARK AT LOCATION FOR LHPS145. WALK DOWN STREAM AT LHPS145 TO WATER. WALK ALONG SHORE TOWARD THE RTE 1A BRIDGE. PASS UNDER 2 PIERS AND THEN TURN A CORNER TO THE RIGHT. GO ANOTHER 100 YARDS. THE SOURCE IS IN A THICKET IN THE CORNER. YOU WILL PASS LHPS081.
Latitude	43 3' 21" N
Longitude	-70 44' 55" W

StationID	T7
Town	RYE
StationDescr	UPSTREAM OF BRIDGE OVER BERRYS BROOK ON BRACKETT ROAD (WEST SIDE OF BRIDGE). WHEN FACING UPSTREAM, TAKE SAMPLE FROM THE RIGHT SIDE OF THE BROOK USING A SAMPLING POLE. GET AS CLOSE AS POSSIBLE TO THE MIDDLE OF THE STREAM BY STANDING ON ROCKS.
Directions to	TAKE ROUTE 1A FROM PORTSMOUTH TOWARD ODIORNE STATE PARK IN RYE. BEFORE REACHING THE ROUTE 1A WOODEN BRIDGE, TURN RIGHT ONTO BRACKETT ROAD. FOLLOW BRACKETT ROAD UNTIL IT CROSSES BERRYS BROOK (1/4 MILE). PARK IN PULL-OUT ON RIGHT SIDE BEFORE THE BRIDGE.
Latitude	43 2' 37" N
Longitude	-70 44' 4" W

StationID	T14
Town	RYE
StationDescr	BERRY'S BROOK AT ROUTE 1A WOODEN BRIDGE. COLLECT SAMPLE FROM THE MIDDLE OF THE BRIDGE FROM THE SIDE FACING AWAY FROM THE OCEAN. LOWER BOTTLE HOLDER TO WATER TO COLLECT SAMPLE.
Directions to	FROM PORTSMOUTH, TAKE ROUTE 1A TOWARDS ODIORNE STATE PARK. PARK IN THE DIRT PULL-OFF ON THE BEFORE THE WOODEN BRIDGE.
Latitude	43 2' 52" N
Longitude	-70 43' 40" W

StationID	T18
Town	PORTSMOUTH
StationDescr	SAGAMORE CREEK AT ROUTE 1A BRIDGE. COLLECT SAMPLE FROM THE MIDDLE OF THE BRIDGE ON THE SIDE FACING AWAY FROM THE OCEAN. LOWER BOTTLE HOLDER TO WATER TO COLLECT SAMPLE.
Directions to	TAKE ROUTE 1A SOUTH FROM PORTSMOUTH. PARK IN PARKING LOT FOR SAGAMORE GENERAL STORE ON THE SOUTH SIDE OF THE BRIDGE.
Latitude	43 3' 16" N
Longitude	-70 44' 55" W

StationID	T13A
Town	PORTSMOUTH
StationDescr	BACK CHANNEL FROM ROUTE 1B BRIDGE. COLLECT SAMPLE FROM THE MIDDLE OF THE BRIDGE ON THE SIDE CLOSEST TO BACK CHANNEL. LOWER BOTTLE HOLDER TO WATER TO COLLECT SAMPLE.
Directions to	PARK ON ROUTE 1B AT THE WEST SIDE OF THE BRIDGE. CROSS THE ROAD AND WALK ACROSS THE BRIDGE ON THE BACK CHANNEL SIDE WHERE THERE IS A SIDEWALK.
Latitude	43 3' 29" N
Longitude	-70 43' 47" W

Stations to be sampled by the Boat Team

STATIONID	TOWN	STATION DESCRIPTION
LHB1	NEW CASTLE	OFF FROST POINT JETTY AT GREEN CAN AT MOUTH OF LITTLE HARBOR
LHB13	NEW CASTLE	BACK CHANNEL AT ROUTE 1B BRIDGE BY WENTWORTH MARINA (DOWNSTREAM/LH SIDE)
LHB16	NEW CASTLE	MIDDLE OF BACK CHANNEL
LHB18	PORTSMOUTH	SAGAMORE CREEK AT ROUTE 1A BRIDGE (UPSTREAM SIDE)
LHB19	PORTSMOUTH	SAGAMORE CREEK NARROWS DOWNSTREAM OF WITCH COVE MARINA
LHB2	NEW CASTLE	ALONG NEW CASTLE SHORELINE
LHB5	NEW CASTLE	BETWEEN SHAPLEIGH AND GOAT ISLANDS, NORTH EDGE OF BACK CHANNEL
LHB6	RYE	WITCH CREEK AT SHEAFES POINT
LHB8	PORTSMOUTH	WITCH COVE MARINA IN SAGAMORE CREEK
LHB9	PORTSMOUTH	BETWEEN SHAPLEIGH AND MAINLAND, NORTH EDGE OF BACK CHANNEL
T6	RYE	WITCH CREEK AT SHEAFES POINT. SAMPLE COLLECTED FROM A BOAT AS CLOSE TO SHORE AS POSSIBLE.